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AMERICAN AND EUROPEAN METHODS COMPARED AT GLASS DIVISION MEETING

IDEAS from over the seas was the theme of the summer meeting of the Glass Division of the American Ceramic Society, at Cambridge Springs, Pa., Oct. 23-24. The papers read consisted of the observations of the various delegates to the International Congress on Glass, held in London in July. What are the developments in Europe of interest to glass technologists?

Much of the success of the meeting was contributed by the good nature and fellowship of glass technologists from several foreign lands. In this group were the following: A. Lecron, Belgium; B. Long, France; J. E. Ganlis, France; L. S. Vello, France; J. B. Mitford, England; L. A. Forbes, England; A. B. Karasin, Russia; S. Perlin, Russia; H. Ota, Japan; and W. Weyl of Germany who is at present at Penn State.

The meeting was officially opened Friday afternoon by Chairman J. S. Gregorius, who read a cable from Professor W. E. S. Turner wishing the Division a successful meeting. Brief abstracts of the papers read follow:

Faces, Facts, Fotografs and Fables by *Francis Flint.*

Dr. Flint disclaims credit for the selection of the title to his paper. None the less, it aptly summarizes his talk, illustrated by slides, on the experiences and impressions of the American delegation to the International Congress in London. The most outstanding impression left on the minds of our glassmen was the opportunity this meeting afforded to meet men who heretofore had been merely names to them. And Dr. Flint succeeded admirably in bringing this same impression back to the Glass Division members who had not been overseas.

In quick succession, he showed informal photographs, with titles of a kind not usually found in the literature of glass technology—W. E. S. Turner whose hobby is mountain climbing; Berger, possessing a rare sense of humor; Maurach, who invited the Congress to Germany in 1939; Schultze, our guide down the Rhine and possessing a most elaborate index of world literature on glass; Delloye, dean of the French delegation; Dudding, president of the British Society; Long of France and Ota of Japan, both of whom were in the Cambridge Springs audience; Parkin, Finn's right hand man throughout the Conference; Miss Violet Dimbleby, the belle of glass technology; Ctyroky, Marchand, Schoonenberg, Polivka, Schott.

Dr. Flint mentioned how strongly the American delegation was impressed by the mid-afternoon rite of "tea," which they ran into everywhere and which seemed to take precedence over all business of the moment. After our men had become accustomed to this new habit, they began to see that this custom had a real place in business routine, affording relaxation and a stimulus to better work.

Commenting generally on practice here and abroad, Dr. Flint expressed the opinion that in glass house operation, America is ahead of England and Germany. This may perhaps be due to the fact that our resources, facilities and exchange of information is somewhat ahead. However, insofar as publications are concerned, Europe seems to be ahead due, no doubt, to the encouragement which European firms give their engineers to publish their findings.

Dr. Flint pointed out that in England and many parts of Europe, there is a tendency toward German tanks and American glass machines. However, their acceptance of machinery tends to lag because of the cheapness of labor. He also commented on the excellence of Czechoslovakian glass, saying that the ware which we usually receive in this country is not typical of their best. Czechoslovakia, incidentally, has an excellent institute of research and a fine art school.

Chemical Durability at Home and Abroad—a Resume by *Donald E. Sharp.*

Mr. Sharp pointed out that there appears to be as much difference of opinion on this subject in Europe as there is here. In London the group went on record as being of the opinion that some type of powder method showed the most promise for testing glass as glass. However, they did not advocate any specific method.

In the discussion following, W. C. Taylor brought out that the future action of the Glass Division in respect to chemical durability would probably be centered around a committee of the American Society of Testing Materials. Several methods of testing are at present being considered by this group.

Standard Tests and Specifications for Glass—A Discussion of the National, Foreign and International Aspects and Prospects by *Samuel R. Scholes.*

Dr. Scholes stated that he believes the procedure for glass analysis as set forth by Dr. Lundall and his committee some years ago—at present referred to as the "tentative" method—should be fully adopted by the Glass Division as standard, and be used as such. He also suggested the same course be adopted with the method proposed by the committee on chemical durability and proven useful by cooperative tests carried out in 1934. He suggested these tests be adopted as standard with a provision for later amendments.

Reference was made to the methods of glass classification for chemical durability, being used or tried in foreign lands (England, Czechoslovakia and Germany) with emphasis on the D G G method used in Germany;

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Reading from left to right: In the small square are Drs. Tillotson and Silverman; next is Hettinger, demonstrating his internationally famous light units in competition with Silverman's panoramic movie; looking for somebody or something are Don Sharp, Heinie Blau, Hiller and Francis Flint. To the right is the foreign delegation, complete except for three who dodged the cameraman.

Top: After having posed once for the panoramic camera, the group at the extreme left are rushing around to get in the picture again. Next below: here the photographer succeeded in corraling almost the complete Glass Division. The dining room, showing hungry technologists at their victuals. And bottom: a part of the hotel and its attractive surroundings.

Left: Hettinger is doing something to his camera while Hostetter seems more interested in that piece of paper; Morey shows it to Bowes; Harth and Ota of Japan are discussing Barium; extreme right, Blau giving moral support to the camera-shy Finn.

where mention of using the D G G method amply describes the manner of testing.

Dr. Scholes brought out the difficulties attending international adoption of standard methods, in spite of which the International Congress has made a start by acting as a clearing house and as an executive body to consider and place in effect these international standards. Recommendations presented at the Congress, on glass analysis and the chemistry of glass, were read.

The European Glass Fiber Industry by *James Slayter.*

An excellent resume of the glass wool industry in Europe was given by Mr. Slayter, including a brief history of the industry in Germany from the time of making glass wool by softening glass rods and winding the tread on bicycle wheels up to the present. This report emphasized that, because of the lack of asbestos in Europe, the glass wool industry is rapidly growing

Above left: Taylor and Dr. Weyl pose for pictures between sessions, while the others mill around; next, a group on their way to the dining room; extreme right, Spencer cogitates while Babcock relaxes.

being adopted for insulating material. Consequently it should be profitable to install the more modern American processes with their higher rate of production.

Glass wool, in addition to insulation, is being put to more uses in Europe at present than in America. Interesting uses to which it has been put in Europe are: as a textile, to fill automobile mufflers, separating plates for batteries, pressed into sheets for insulating board, and in Italy a thin layer of glass wool between the pieces of sheet glass, the ends sealed with compound, is used in skylights to cut out the heat of the sun. "The Engineer-

ing Aspects of European Glass Plants" by J. Earl Frazier.

This interesting paper is presented in full on page 373.

A Review of the Reports on Physical Properties of Glass by *Louis Navias.*

Mr. Navias very ably gave a review of the papers presented at the Congress which dealt with the physical properties of glass. The character of papers covered in this report make a worthwhile abstract impossible. Therefore, we are listing the papers dealing with the subject reported by Mr. Navias:

1. "The Thermal Endurance of Glass" by W. M. Hampton.
2. "General Methods for the Determination of the Thermal Endurance of Glass" by H. Schonborn.
3. "Thermal Endurance of Glass Articles" by R. W. Douglas.
4. "Thermal Endurance Tests for Glassware" by J. B. Murgatroyd.
5. "Thermal Endurance of Glass" by K. Tabat and T. Moriya.

Papers dealing with the mechanical properties of glass were also briefly discussed together with the resolution passed by the committee on this subject.

In the discussion that followed the report, the necessity for bringing tensile strength values into a formula for thermal endurance was brought out. Dr. Preston pointed out that since the equations did not include such a value, the indications was that the glasses tested must have had about the same tensile strength. Dr. Preston questioned the value of the equations presented because they had not proven by experimental means under various conditions of testing.

Safety Glass in Europe and America by *E. L. Hettinger.*

Mr. Hettinger gave his observations on safety glass in Europe and compared its use there with its use in America. He brought out the fact that the use of safety glass in America is by far more general. It was also mentioned that no regulations are in force there for the use of safety glass, except those introduced through lower insurance rates.

Synthetic glasses to some extent take the place of safety glass in Europe. While they have no sharp edges when broken, they do have the great disadvantage of a very low resistance to surface abrasion and the surface undergoes deterioration in time.

During the discussion Dr. Forbes of England stated that the British Air Ministry has recently passed some regulation on safety glass and that standard specifications are being drawn up. He also mentioned that the safety glass industry there, is practically in the hands of a single company.

My Impressions of European Glass Technology by *N. W. Taylor.*

Dr. Taylor stated we need not fear competition from Europe on machine made products, but rather competition can be expected in art ware and special products where value is introduced largely by the use of skilled labor.

Regarding the topics at technical sessions, Dr. Taylor felt that there was an over-emphasis on practical matters and an opportunity lost to discuss the fundamentals of glass itself. However, he did mention a number of workers who have been and are doing excellent work in glass technology.

Some Impressions of European "Standard" Methods of Chemical Analyses by *A. N. Finn.*

A great deal of interest was shown in methods of determining iron in glass and sand. Most of the methods are empirical and used for control work in the various plants. They have not been tried out by any great number of laboratories and their general usefulness is, therefore, rather uncertain.

The method of determining alkali in glass by blowing thin films of glass, digesting a small sample (20 mg.) of the thin glass in an autoclave and then titrating the solution with standard acid, seems to hold some promise of being useful where speed is required.

In Germany, the determination of Al_2O_3 in the presence of flourine has been simplified by boiling the alumina precipitate 10 minutes. The results are said to be satisfactory. In the determination of flourine, Lanthanum Acetate is being successfully used.

In general Dr. Finn feels we are ahead of Europe in methods of glass analysis insofar as having standard methods are concerned, because of the cooperative work which has been carried on and the use of standard samples as basis of comparison.

In the discussion that followed, Dr. Scholes stated that he believes a larger sample should be used for determining alkali by the method described. Dr. Silverman asked whether the loss of alkali in blowing the thin glass bubble was not a serious problem and Dr. Finn stated that the results found by this method were comparable with the J. Lawrence Smith method.

Dr. Navias suggested the possibility of causing the molten glass to foam by the use of a vacuum and using the solidified foam in place of the thin blown bubble as a sample. Dr. Finn did not think the glass film so formed would be thin enough and thought that the larger losses of alkali by this treatment might cause errors.

The Activities of the International Commission on Glass by *J. C. Hostetter.*

Dr. Hostetter read the resolutions and recommendations adopted by the various groups at the International meeting this summer and submitted them for action to the Division. At the suggestion of several members it was decided to have these printed before the annual meeting of the American Ceramic Society next spring, thus giving all those interested sufficient time to become acquainted with them before official action is taken.

The next meeting of the International Glass Congress is to be in Germany in 1939 and the one following that (1942) will probably be in America. Dr. Hostetter stressed the need for the cooperation of the various national standard groups with the international body.

Left: Navias walks away from the photographer; right: a scene at one of the meetings.

ENGINEERING ASPECTS OF EUROPEAN GLASS PLANTS

By J. EARL FRAZIER
Simplex Engineering Co.

THE purpose of this paper* is to describe the equipment and designs to be found in several European glass plants. To better explain these visits, comparisons will be made with what I consider at this time to be the best, the latest practices and engineered installations in the United States.

On taking a trip through the Charlton Works of the United Glass Bottle Manufacturers Ltd. in England, I was immediately reminded of the Alton, Ill., plant of the Owens-Illinois Glass Co. I saw four cross fire regenerative oil heated 40-ton tanks, with eight 10-foot diameter recuperatively fired single burner with automatic control revolving pots and eight (8) 10-arm Owens Suction Machines, which are of the "AN" and the "AR" Types. The smaller bottles in this Charlton Plant, and up to and including 6-ounces in weight are made on the "AN" Machines, and the larger sizes are made on the "AR" Machines. There are also four (4) single arm Roirant Suction Machines in this plant. Metal tubes have been used in these revolving pot furnace recuperators, and due to the excessively high maintenance are being replaced by Carborundum or other materials of a ceramic nature.

Sillimanite slip cast flux blocks are used thruout in the sidewalls and also in the bottom of the melting ends with excellent results. These blocks have been used extensively for the last two years by this English glass manufacturing organization. Such blocks are fired at a temperature of 1450° C. (2642° Fahrenheit), and the Sillimanite content is about 80 per cent with the weight per cubic foot at 140 pounds. Comparing this block with a standard British or American flux block, which has a density of approximately 128 pounds per cubic foot, or with Corhart which has a density of approximately 185 pounds per cubic foot, we have a block somewhere in between these two, both for density and cost. These blocks appear to be very insoluble, reported to wear away smoothly giving at all times a clean non-cordy glass. The life of such blocks under the same conditions compared to standard British flux blocks is about 300 per cent above normal.

According to "Joblings," who own the Pyrex patents in England, these blocks give excellent service on their Pyrex tanks. In practice, a customer starts with the weak places in a tank, namely the throat and doghouse corners, and after experiencing a long life makes the next fire more extensive. Others start with feeder parts such as channel and suction machine forehearths, and after finding that they obtain smooth blocks with very little wear, and have obtained clean metal all through the run they extend the use of the material to the tank.

Electric lehrs of the four-foot wide variety are used with each lehr having a plow type automatic stacker and conveyor where the ware is delivered from an Owens Machine. Each lehr is equipped with a small amount of city gas heat supplied by a single pipe burner, which gas is not only desirable for its heat content, but more so for the lighting effect on the inside of the lehr, which can be used to advantage for inspection, etc. These lehrs are of the low heat steel insulated type similar to American design.

The electric elements, however, are placed on the sides of the lehrs under the conveyor while American practice is to place electric elements above and below the conveyor extending the heating elements all the way across, making the radiating metal material less heavy in the center of the lehr.

A batch system or plant consisting of concrete storage silos with an electric motor driven batch traveling weighing car greets one. After the batch is weighed and mixed it is conveyed by elevator to hoppers directly over the tank. Of course in this country we would use a hopper monorail system for feeding the tanks and the weighing scales would be located on the individual material hopper outlets of each storage silo, preferably controlled by a photoelectric cell weighing mechanism. I feel sure most technologists and engineers here will agree that the monorail system is better, and most desirable.

A rotary coke-fired sand drier with a capacity of approximately 3 tons of wet sand per hour delivers dry sand to the storage silos. We are very fortunate indeed in this country in being able to get at all times dry sand directly from reliable suppliers.

Rotary screw propeller type batch chargers are popular and are used on each of the tanks in this plant. I do not like this method of feeding raw materials to a tank, especially if the tank is being continuously pulled to its maximum melting capacity. I like the manual submerged batch pile type method of feeding better for heavy demands, as it keeps the raw materials from reaching the bridgewall before being melted. This, of course, is open to discussion.

I observed a suspended type of crown of the Stein-Atkinson design installed on one of the tanks. The managers claimed it was good for at least three or more fires, and that at the end of three years the upkeep would then be very small, as usually only a few tile or brick replacements here and there are necessary. American manufacturers are likewise using suspended crowns on tanks and furnaces, particularly where there is a great up and down temperature variation. Such a crown eliminates the necessary work of loosening and tightening tie rods, and gives a better control of the flame due to the close proximity of it to the melting charge with no dead air space as you have on sprung type crowns. Crown insulation has not, so I understand, been tried in this plant to any great extent, or with any great success. I understand crown insulation on large size units is seldom tried in European plants.

A water softening plant of the soda lime type for the power house boilers, which are Babcock & Wilcox with chain grate stokers was in use. A spare Chapman Producer Gas Plant with six ten-foot Chapman-Stein Producers with automatic agitators and an automatic ash removal system is ready for operation at any time.

Air is used to atomize the oil which is somewhat near Bunker "C" gravity. Such air is supplied by two steam driven single stage air compressors which deliver

* A description of several European glass plants visited by the author when he was attending the International Congress on Glass last summer. From a paper delivered before the summer meeting of the Glass Division of the American Ceramic Society.

1650 cubic feet of free air per minute at 30 pounds gage pressure. This low pressure system seems to work very well. High pressure and low pressure oil systems are always a subject for discussion.

There is a wharf for shipping finished ware and for receiving raw materials by boat, and the company also has a cap closure plant. The setup is similar to American practice.

The machines such as lathes, planers, master tracers, etc., in the well lighted mould shop were mostly of American manufacture. A very modern plant is the phrase to describe this Charlton Works.

On visiting the Hellerup Glasvaerk at Copenhagen, a plant of the United Glass Works of Denmark, I again saw Owens Vacuum Machines, but the six-arm type instead of the ten-arm, as was seen at United Glass Bottle Manufacturers Ltd., at Charlton. Producer gas made with coal shipped from England is burned on not only the two regenerative tanks, but also on the two 3½ meters wide (11-feet 6-inches) continuous pan type semi-muffle lehrs.

Hand shops are also worked on the same tank, but the gathering for these shops is done in a channel or workhole in the tank near but outside of the revolving pot. Beverage bottles of amber and dark green mostly for beer or wine are the principal products produced.

The batch plant consists of sturdy weighing scales only, without any mixer, weigh and proportion the raw materials. An automatic former coal stoker batch charger feeds and mixes these glass forming components into a continuous charge as they go through the doghouse into the tanks. These tanks are reported to last at least three years for each fire, but the glass pull however, is only about one-third average American container practice.

I shall digress for a moment from engineering and say, "As a matter of interest I was told that with the 3½ million people living in Denmark, the demand or consumption of beer sold in bottles is around 600,000,000 bottles per year." If one should assume that there are 1½ million people in Denmark who would drink beer, the consumption would then be about 400 bottles per person per year. Should such a condition exist in United States the container people would need much more capacity. I found canned beer was not popular in my travels in ten countries. In fact I didn't see any canned beer in Europe.

On visiting the modern plant of the United Glass Works at Schiedam, Holland, which is near Rotterdam, one would see some Hartford Equipment, Lynch Machines, Ed Miller Machines, Wm. J. Miller Machines, and the like. In one of this company's plants Owen Suction Machines are in operation. A miscellaneous type of ware is produced at present, and perhaps glass bricks will be manufactured by this organization in the very near future. Oil as fuel seems to predominate. One could also see batch materials being fed through the roof of the tank, close to the rear or back wall. The results achieved were very satisfactory. The no-doghouse tanks have been tried in this country.

I visited Brevort Glass Works at Jumet near Charleroi, Belgium, and saw the new Roirant 6-arm vacuum machine working on a cross-fire producer gas regenerator tank that has a revolving pot built into the main tank itself. This cuts down the heat losses to such an extent that no regenerator or recuperator is necessary or recommended for the revolving pot. In this plant I also saw a regenerative tank with eleven single arm Roirant Machines on it, and all the machines making a good European standard beverage bottle in either dark green or amber color glass. A variety of push up bottom wine bottles are also manufactured in this plant. New 4-foot wide electric lehrs with the heating elements under the conveying mechanism are at present being installed. The conveyors on these lehrs consist of thin bars of steel which rotate and work off eccentric shafts which method advances or progresses the bottles through the lehr.

On a visit through the glass plant of Zaklady Premyslowe Vitrum in Poland one would see tableware, sheet glass and most every type of ware manufactured. Hand production and also an old style multi-machine Fourcault sheet glass drawing system greet one. If one should also visit the plant of the Glaswerke Klimczak I Synowie one would see chemical ware of all sorts being made by hand. Producer gas is the predominating heating medium in most Polish factories. It is not uncommon for the general manager's home to be within the plant site itself. In America most managers wish to get as far away from the plant as possible for their periods of relaxation, or where the telephone is the usual means of communication.

A good many manufacturing plants in Europe have the traditional brick sidewall buildings with clay tile roofs, which most glass manufacturers know are entirely too hot for American production methods, that is, in the manufacturing or factory working departments. Steel columns, trusses, beams to a large extent were encased in concrete in most plants, which make any changes that may be necessary for new equipment installations very expensive. There was a very decided lack of ventilating systems for removing heat from the workers handling the forming machines, or producing at the shops, such as we have here in the United States. Of course in central and Northern Europe it does not get as warm as it does in the United States.

The tendency towards mass production is much more noticeable in these European plants now than it was when I visited plants with the American Ceramic group on their European Tour in 1928. The technical control although excellent does not seem to be the predominating feature nearly so much as it was at that time. A large tank or furnace in 1928 would have absolutely no insulation on regenerators and ports, but now to a certain extent a variety of silocel type brick insulation or insulating firebrick is finding its place, but I feel sure not nearly so much as here in this country. One reason I believe is that we may have cheaper better refractories here in America, which will stand insulation, or else the demand on European tanks, and furnaces, does not justify the expense involved for insulating compared to the savings realized from such reduction in heat losses.

English as a general rule and also other Europeans contacted do not seem to show much interest in the Cornelinson system of melting glass by electrical means, that is the immersing of electrodes, (which are usually Swedish iron, etc.) into the melt, similar to that which

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PLANT METHOD FOR VISCOSITY MEASUREMENTS OF GLASS

By WILLI M. COHN*

VISCOSITY measurements of glasses at high temperatures require as a rule a rather complicated setup for obtaining accurate values. Most methods use a rotating cylinder or a falling ball. The most important region for the glassmaker, however, is the semi-liquid condition of the glass which cannot easily be measured by these methods. I have developed a simple method for the semi-liquid region which can be easily operated at the plant. This method is based on my method for measuring glass viscosity by means of free falling spheres[1].

The improved Stoke's law for a liquid in a crucible is

$$\eta = \frac{2gR^2 \quad (d_1-d_2)(1-\frac{R}{r})^{2,25}}{9u \quad (1+3,3\frac{R}{h})}$$

In this formula mean η the viscosity, g the gravity, R the radius of the sphere, r the radius of the container with the melt, d_1 and d_2 the densities of the sphere and melt, u the rate of fall of the sphere, and h the height through which the sphere falls.

Method

An experimental furnace with a winding of platinum-rhodium wire or a Globar furnace is used into which a crucible of six inches height and two inches diameter of highly refractory, such as sillimanite, material is placed.

The glass is melted in this crucible until it is free of bubbles and then cooled down to the temperature where it is in a semi-liquid state. After the melt has obtained a temperature equilibrium, measured by means of one or two thermocouples, a sphere made from platinum—20 per cent rhodium of about 10 mm. diameter is dropped into the melt. After a certain length of time, for instance 60 minutes, a second sphere B, and again after 120 minutes a third sphere C, is dropped into the melt.

120 minutes after dropping the third sphere the crucible with the glass melt is quickly removed from the furnace and cooled in Sil-O-Cel powder. Upon reaching room temperature the crucible is split along its axis and the distance measured travelled by the spheres. Since the temperature in such a long crucible is, as a rule, not uniform over the entire height of the crucible, the ends usually being cooler, readings are only made for spheres which are close to the middle part of the crucible. Fig. 1 shows the position of the spheres at room temperature.

Suppose sphere A has travelled a mm. within 240 minutes and sphere B, b mm. within 180 minutes. The distance h_1 is equal to a-b mm., and the time for travelling h_1 is equal to 240-180 = 60 minutes. Similarly, h_2 is equal to b-c mm.

This method of computing makes unnecessary a determination of the height of the melt in the crucible which is difficult to obtain accurately. It also eliminates the small movement of the spheres in the melt during and after removal of the melt from the kiln, this movement being practically the same for all spheres in the middle part of the crucible. The data obtained give the rate of fall, u, in the middle part of the crucible. Density values of the glasses and the sphere may be obtained from the literature or determined directly[1]. Inserting these values and the remaining constants in the above formula gives the viscosity of the glass at this particular temperature. Viscosity values for other temperatures are obtained by further melts.

Results

The viscosity values obtained were reproducible, the maximum deviation of the values being ±3 per cent. The range of the measurements was between 30,000 and 1,300,000 poises. Results were obtained down to as low as 820°C (1508°F.). If the glass melt is too fluid, this method cannot be used, of course, because the balls will pass too fast through the melt. A few values for two glass melts are given in Table I. The results are plotted in Fig. 2. The composition of the glasses is shown in Table II.

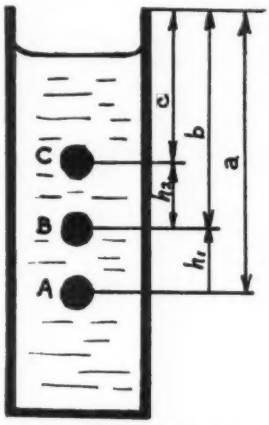

Fig. 1. Position of balls in glass after cooling down to room temperature.

The data obtained show the influence of an addition of a small amount of BaO in lowering the viscosity of the melt, particularly at higher temperatures.

Viscosity Measurements in Glass Tanks

The same principle can be applied for controlling the viscosity of the melt in glass tanks. The ball is fastened to a solid rod of small diameter. The rod is supported in a vertical position by two bearings and has a pointer which reads on a scale. At the end of the rod, a platform is arranged for supporting weights.

The ball is lowered to the surface of the glass melt or to a certain depth within the melt and this position

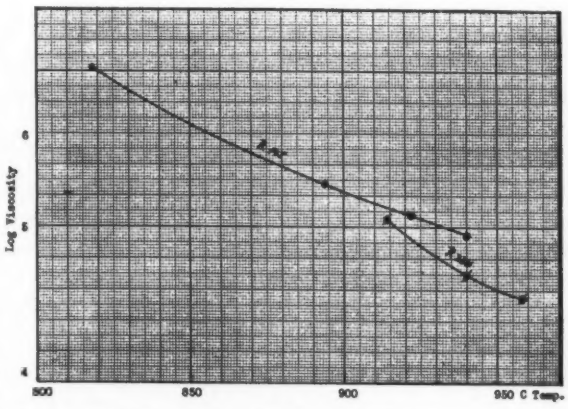

Fig. 2. Viscosity of glasses R 145 and R 230.

TABLE I. Viscosity Values of Glasses R 145 and R 230.

Glass	Melt No.	Temperature in ° C.	Time of fall in minutes	Distance h in melt in mm.	Viscosity η in poises	Log η
R 145	I	818	60	14.4	1.047.000	6.01995
	II	894	50	54.7	186.500	5.27068
	III	922	40	72.2	121.400	5.08422
	IV	940	60	165.6	90.700	4.95761
R 230	I	914	30	55.1	111.200	5.04610
	II	958	12	72.9	35.600	4.55145
	III	940	18	82.5	48.900	4.68931

TABLE II. Analysis of Glasses R 145 and R 230.

Material	R 145	R 230
SiO_2	74.5%	74.0
Alkalies	14.4	14.5
$Al_2O_3 + Fe_2O_3$	1.5	1.6
MgO	3.8	3.5
CaO	5.7	5.7
BaO	...	0.6

marked on the scale. A certain load is then placed on the platform. The time is determined which the ball requires to travel in the melt by two inches or a similar distance. This arrangement is somewhat similar to the method which I developed for measuring the workability of clays and which is being used now in many plants[2].

The time of penetration of the ball-rod-load arrangement into the melt remains the same if the viscosity of the melt remains constant, the viscosity being determined both by composition and temperature of the melt. If the viscosity changes, the depth of penetration into the melt within a certain length of time will be different.

I found in some cases that it is preferable to use a ball floating at a certain depth within the melt. This is done by connecting the rod with a wire, guiding the wire over a pulley and suspending the weight at the other end of the wire.

These devices may be calibrated using several glass melts the viscosity of which has been measured by one of the absolute methods, but very often relative measurements are entirely satisfactory for plant operation. Taking readings every hour or so will facilitate considerably the supervision of the melting process and securing uniform products.

All these devices can easily be connected to indicating or recording instruments, or may operate a red light if the viscosity reaches the danger point.

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[1]Willi M. Cohn, Annalen d. Physik (5), 21, 761-782, 1935. Willi M. Cohn, Berichte D. Keram. Ges. 15, 551-558, 1934.

[2]Willi M. Cohn, Berichte D. Keram. Ges. 10, 245-257, 1929.

TENSILE PROPERTIES OF DRY-PRESS BRICKS

The brittleness of refractory products has in the past been a serious handicap to the study of their tensile properties. Within recent years the development of the optical strain gage for measuring minute length changes has given the research worker a tool which has eliminated most of the difficulties encountered in such a study, so that strain measurements of all types of refractory materials can be made with reasonable accuracy.

Although refractories are ordinarily subjected to comparatively small external loads, more information on their little known structural properties may lead to a better understanding of their behavior in certain types of service. A knowledge of the tensile properties of fired refractory products is desirable because of the trend toward the use of fairly large shapes in hanging roofs designed for modern high-power boiler settings, heat-treating and other furnaces. Also there is often a decided lack of agreement in results of certain tests of apparently duplicate samples of refractory bricks or shapes.

A study was, therefore, undertaken at the Bureau to make available information on the tensile properties of the standard 9-inch size of firebrick, and also the extent of the variation in these properties within the brick and between bricks. This shape is produced in largest quantities, is readily obtainable, and enables a selection representative of the different localities and processes of manufacture, different degrees of heating, and different methods of setting in the kiln. The specimens used for study were machined from sections, the axes of which were initially lengthwise or crosswise to the brick.

A report has been released for publication giving information on the tensile properties of 16 brands of fire-clay brick, two of high alumina and one each of silica, chrome, forsterite, and mullite. The results of tests made on nine specimens (6 lengthwise and 3 crosswise of the brick) of 3 bricks of each brand show that the range in Young's modulus of elasticity was from 485,000 lb./in.^{2} to 5,255,000 lb./in.^{2}, the range in tensile strength from 115 lb./in.^{2} to 1,005 lb./in.^{2}, and the range in extensibility from 0.0120 to 0.0465 per cent. For dry-press bricks Young's modulus of elasticity of the crosswise specimens was greater than that of the lengthwise specimens; for stiff-mud extruded brick the modulus was less for the crosswise specimens than that for the lengthwise; and for the hand-made brick the moduli of elasticity of the crosswise and lengthwise specimens were nearly the same. The handmade bricks showed more variation in properties from one brick to the next than either the dry-press or stiff-mud bricks. However, the range in maximum and minimum values for individual handmade bricks was less than that for the other two types.

In general, bricks formed by the dry-press process had greater extensibilities than those formed by either the handmade or stiff-mud process. The highly siliceous fire-clay brick and the silica brick, each having higher silica content than the other brands, and both made by the handmade process, had higher extensibilities than any of the other brands.

Results of tests limited to one brand of dry-press bricks indicate that tensile properties of specimens cut from the bricks after firing are significantly affected by axial load during firing of the bricks in the kiln.—*Technical News Bulletin of the National Bureau of Standards, August* 1936.

LOOMIS RETURNS TO OHIO STATE

George A. Loomis, who has been on leave of absence from Ohio State for the past 18 months, returned to the University Sept. 1 to resume his position as Research Engineer and Assistant Professor of Ceramic Engineering. Mr. Loomis has been engaged in special work for the Ohio Valley Clay Company, Steubenville, O., and will continue to serve this company as consultant.

SLUDGE IN HEAVY GRADES OF FUEL OIL

DUE to both the increased cost of the lighter grades of fuel oil, the higher B. T. U. value (based on a volume basis) of the heavier type fuel oils, the present tendency in glass plants having oil burning installations is towards the adoption of the heavy grades of fuel oil. While the properties of many of the heavy fuel oils still conform with the specifications of Bunker "C" oil as defined by the Federal Specifications Board, the increased use of cracked residues in the Bunker "C" grade oil has materially altered the properties of other heavy oils and their use as a source of heat for glass furnaces especially those melting flint glass. This has given rise to various operating troubles which were not experienced when the usual type Bunker "C" or the lighter fuel oils were used.

These new operating difficulties have arisen chiefly from the deposition of carbon or carbonaceous material which is formed when oils are subjected to excessive cracking. This material is present in the cracked residue as fine particles in suspension or in unstable solution. During storage, particularly in the storage tank from which the burner supply is being drawn and in which the oil is in motion to some extent due to the action of the pump and the return line, these particles flocculate and the resulting sludge tends to settle out. While this accumulation in the storage tanks is bothersome, the most serious difficulty is usually experienced in the oil heaters located between the tank and the burners. Coagulation of the carbon particles will take place in the heater and will cause both poor heat transfer and clogging of the heater.

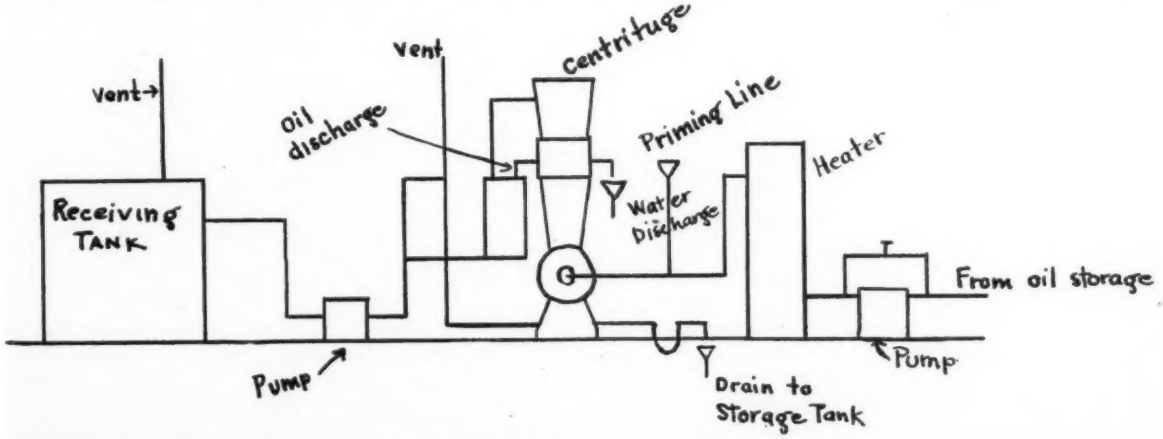
In addition to the carbon particles and the carbonaceous material, cracked residues also have high ash content. Samples of ash from the sludge of a Bunker "C" type oil showed on analysis a high percentage of iron, silica, lime, soda, nickel, sulphates and traces of rarer minerals such as vanadium. Much of the ash content is in the form of particles of dirt and as such contribute to the clogging difficulties.

If a change-over from light oil to the Bunker "C" type of oil is being considered it is advisable to secure samples of oil from various sources and to determine the sludge contents and the tendency of the oils to form sludge. Needless to say the oil showing the lowest sludge content is the most preferable for glass factory use.

A quick check on the sludge content may be made by placing a drop of the oil on a glass slide and allowing it to flow so as to form a thin streak of oil on the slide. Examination of this streak with a powered microscope using a bright light source will disclose the sludge forming material as small black particles of varying sizes. If several oils are examined in this manner the one containing the smallest amount of sludge can be judged by visual means very easily. By heating the oils to various temperatures and for various time intervals followed by an examination of their streaks with the microscope the sludge forming tendencies of the various oils can be determined.

A more exact determination of the sludge content may be made by using a modification of the A. S. T. M. method for determining the amount of sediment in oil (A. S. T. M. method D96-24). The oil is diluted with an equal volume of light fuel oil (some forms of sludge are soluble in benzol), heated for 10 minutes at 150° F. and then centrifuged at a speed of 1500 r.p.m. for 10 minutes. Since the dilution is carried out in a graduated centrifuge tube, an examination of the bottom of the tube in a strong light will show the amount of sludge thrown down. By treating the oils at various temperatures and for various time intervals before centrifuging, the tendency to form sludge can be determined by measuring the volume of sludge thrown down after each treatment.

The use of oils containing sludge and mineral salts for glass furnace heating in addition to causing mechanical troubles, such as clogging of the heaters, strainers and the burners, will also cause glass troubles. The particles of sludge resist rapid oxidation very well and when they fall on the glass they undergo slow oxidation and give rise to blisters and seedy glass. The particles of sludge also will cause pitting of the parts and the adjacent furnace walls. The high iron content of the ash has in several cases been the cause of off-color flint glass in furnaces using cracked residue oils. Cracked fuel oils have several advantages:—their pour points are usually low; their viscosity is low for any given gravity and while their B.T.U. content on a weight



● Diagrammatic sketch of centrifuge hook-up for oil cleaning.

basis is only slightly different from that of other fuels, the B.T.U.'s on a gallon basis are much higher due to their gravity. The sludge disadvantage is offset to such an extent by these advantages that it pays to install suitable equipment for removing the sludge and mineral salts before the oil is delivered to the factory lines. Even if an oil of low sludge content is available it is advisable to remove the sludge and thereby eliminate all possibilities of clogging and glass difficulties.

It is possible to design a gravity settling system which can be used in connection with the regular oil storage system and which will reduce the amount of sludge in the oil to a low figure, but the amount of time required for the particles to settle, the necessity of transferring oil into and out of the settling tank without any appreciable agitation and the large tankage required to accommodate the supply that must be kept on hand are factors that make this method impractical for all but those using oil in a limited quantity. Arrangements may often be made with the oil refinery to store the oil to be used in the glass furnace in their empty storage tanks. Shipments are then made from these tanks in rotation. Some settling will then take place while the oil is in the refinery storage.

Filtration of the oil in continuous filter presses will often reduce the sludge content to a satisfactory figure depending upon the effectiveness of the filtration equipment used. The suspended material caught by the filter is controlled by the size aperture used in the press. These apertures must be small enough to prevent the passage of all suspended material but not so small that a layer of solids is quickly built up which, while making an efficient filter medium, will stop the flow of oil and make frequent cleaning of the filter necessary. Filtration is satisfactory for eliminating the larger particles of solid material but the complete removal of all sludge particles including the very fine material is usually not economical by this method.

The most practical and economical method of removing sludge from heavy grade oils is by the use of the centrifuge. The equipment illustrated lends itself to compactness and can be adopted to continuous operation. In the usual type of centrifuge the heated oil is passed into a rapidly rotating bowl and subjected to a force of over 15,000 times the force of gravity. Under these conditions the solid particles in the oil are thrown to the sides of the bowl where they build up into a compact mass. The clean oil is then discharged from the top of the bowl to the storage tank or directly to the factory lines. The volume of oil that can be handled per hour is therefore limited only by the rate at which a proper centrifugal treatment can be effected.

After the sediment capacity of the bowl has been reached (about 10# of sludge is the usual amount depending upon the type of centrifuge in use), the centrifuge must be stopped, the dirty bowl removed and a clean bowl inserted. Unless this procedure is followed, dirty oil will be delivered by the centrifuge as its cleaning power is dependent upon the amount of sludge in the bowl. It is common practice in plants using centrifugal cleaning to change the bowls at fixed intervals. As the rate of oil flow can be kept standard, a little experimentation is all that is necessary to determine the length of time required for the sediment capacity of the bowl to be reached. It is also good practice to fix the time interval in such a manner that the stop is made when the bowl fills up to three fourths its capacity.

If the weight of sludge is determined at each time interval in a routine manner, it will assist the operator in determining the sludge variation of each oil delivery and also help him determine the proper oil temperature and rate of flow thus insuring proper operation of the centrifuge equipment.

WHEATON INCREASES PLANT CAPACITY

On Oct. 19, the new factory recently constructed by T. C. Wheaton Co., Millville, N. J., went into operation. The addition to the Wheaton plant was erected on the site of the original buildings in which the late Dr. T. C. Wheaton began operations in 1888 and laid the foundation for the present company.

The building, which is 100 per cent fire-proof, is constructed of corrugated steel on a steel frame. The "hot metal" section of the building, housing a ten pot furnace, lehrs and kilns, is 24 feet high from floor to eaves and 50 feet high from floor to peak of the M type monitor, to give ample ventilation and pleasant working conditions. The entire building, which also houses the packing and selecting room, paper box and grinding department, measures 80 feet by 190 feet.

The operation of this additional unit is designed to increase the production capacity of the company by approximately 40 per cent.

FOUNDRY PURCHASED BY BALL BROTHERS

Ball Brothers Co., glass container manufacturers of Muncie, Ind., have advised The GLASS INDUSTRY that they recently purchased the Muncie Foundry & Machine Co. This foundry was incorporated in 1899 as successor to another started in 1865. Although the foundry is at present closed down, Ball Brothers plan to re-equip it and operate it for manufacturing castings for their own use and a surplus for the commercial foundry business.

INSULUX BLOCKS FOR FOOD PLANT

Insulux glass blocks are being used in the walls between masonry and steel piers in the new two million dollar building which is being constructed for the Kraft-Phenix Cheese Corporation in Chicago. It is expected that the use of glass blocks will give improved light diffusion, more effective insulation and greater protection from dust.

This year's Power Show, officially known as the Twelfth National Exposition of Power and Mechanical Engineering, will be held at the Grand Central Palace, New York, Nov. 30 to Dec. 5. Featuring the exhibits will be suggestions of new methods to meet new markets.

Formal action in accrediting engineering curricula in educational institutions in New England and Middle Atlantic States by the Engineers' Council for Professional Development has been announced. This group is a conference of engineering bodies organized to enhance the professional status of the engineer through the cooperative support of national organizations representing the professional, technical, educational and legislative phases of the engineer's life.

THE EFFECT OF SOME BATCH MATERIALS ON THE DECOLORIZATION OF GLASS BY SELENIUM

By WILLIAM HORAK

Bailey & Sharp Company

DURING the past several months, a number of articles have appeared in various journals and trade papers, giving the relative effects of certain batch materials on the decolorization of glass by means of selenium. Several of these articles appeared to be based upon work reported by E. J. C. Bowmaker[1]. The conclusions did not seem to agree with the results observed in factory practice in this country, and, at first, the disagreement was blamed upon the difference between the results of large scale operations and those found in the laboratory, on the smaller scale in which the investigations were carried out.

Bowmaker's Table I, is reproduced here, and it will be noted that ten melts are listed with six variable components. No mention was made in the original paper about the cooling or annealing of the samples, but it is a well known fact that the color of glasses containing selenium depends to an important degree on the rate of cooling and on the iron content of the glass. If these were not controlled in the experiments reported, at least one more important variable was introduced.

Sand and soda were designated by Bowmaker under the heading "unchanged components," and although these were constant in the batch, the use of the method of molecular substitution for the variable components caused a change in the SiO_2 and Na_2O contents of the glass as calculated from the batches given in Table I. Such a calculation will reveal that the SiO_2 content varied from about 71.7 to 73 per cent and the Na_2O content from 16.8 to 17.1 per cent. This fact increases the actual number of variables to nine.

TABLE I. DATA OF BOWMAKER'S MELTS AND RESULTS.
BATCH COMPOSITION

(A) Unchanged components:
Sand 16 oz., Soda 5.9 oz., Soda nitre ½ oz.,
Saltcake 1/10 oz., Arsenic 1.13 gm.

(B) Variable Components:

Melt.	Limestone (oz.)	Borax (oz.)	Barium Carbonate (oz.)	Blue (gms.)	Selenium (gms.)	Cullet (oz.)	Color*
1	3.7	¾		0.047	0.014		green
2	3.7	¾		0.047	0.021		normal
3	2.6		0.9	0.070	0.063		purple
4	2.6		0.9	0.047	0.063		pink(1)
5	2.6	¾	0.9	0.047	0.063		pink(2)
6	2.6	¾	0.9	0.047	0.052		pink(3)
7	2.6	¾	0.9	0.047	0.052	8	green
8	2.6	¾	0.9	0.047	0.078	8	pink(5)
9	2.6		0.9	0.047	0.078	8	pink(4)
10	3.7	¾		0.047	0.052	8	normal

* In describing the colors obtained "normal" indicates complete decolorization. Pink (1) to Pink (5) indicated increasing intensity of pinkness in that order, although by no means in any sort of progression. It simply indicates the Pink (5) is more pink than the others.

In interpreting the results, glasses 7 and 10 (Table I) were selected to show that the substitution (molecular) of BaO for part of the CaO lowered the color when B_2O_3 is also present. To show the effect of B_2O_3, when added to the glass as borax, glasses 4 and 5 (Table I) were compared and the data showed that the color was improved. It would have been better if the comparison had been made between glasses containing no B_2O_3 in the first instance, and no BaO in the second. Nevertheless, there are cases where both BaO and B_2O_3 are used in glass, and consequently the data, if correct, are not without value.

Glasses 5 and 6 were not referred to in the original text, but the table shows that glass 6 was pinker than glass 5, and yet the glasses were identical in composition except that the pinker one contained less selenium. This surely establishes the fact that some variables, other than those considered, were affecting the color of the glasses at least as much as those variables that actually were considered.

Moreover, it is impossible to make any kind of comparison as to the effects of BaO and B_2O_3 because of the unequal amounts used. A calculation of the chemical composition of these glasses shows that about 1 per cent B_2O_3 is present and 3 per cent BaO. Not only is the latter three times as great as the B_2O_3 content, but the amount is greatly in excess of that ordinarily used in container glass practice, at least in America.

Since the conclusions arrived at by Bowmaker did not seem to agree with observations on a factory scale, and because of the discrepancies pointed out above, it was decided to investigate certain phases of the matter on a laboratory scale. The prime objective of the new investigations, was to determine, in the proportions and manner of substitution generally employed commercially, the effects of B_2O_3, BaO and sulphates. This last constituent is included because in American practice it is common to introduce the barium as a naturally occurring mixture of the carbonate and sulphate, commercially known as "Barium C Mix."

The base composition used in these tests was a typical average bottle glass batch in which 1 per cent B_2O_3 as boric acid was substituted for 1 per cent sand in one set of melts, and 1 per cent BaO as "Barium C Mix" was substituted for 1 per cent of the CaO in another set. These percentages were chosen because they are typical of commercial practice in America, and it is very seldom that larger amounts, either of barium or boric oxide, are employed in container glass. Furthermore, molecular substitutions are almost never used in commercial practice, at least in America, and consequently, substitutions were made by weight per cent. The introduction of B_2O_3 as boric acid was employed instead of using borax, in the interests of simplification of substitution.

Small scale laboratory meltings are generally understood to give inconsistent results, due to various causes, the chief of which is probably non-uniform temperature conditions in the small laboratory type of furnace. Even when the temperatures of two separate runs are held as closely to the same level as possible by the use of an optical pyrometer, some variation will be found in the

[1] E. J. C. Bowmaker, J. Soc., Glass Tech. 19, 40, (1935).

glasses. Attempts to obtain better comparisons by running several crucibles at one time in a furnace do not successfully overcome the difficulty. For example, four crucibles each containing the same batch and melted at the same time may produce glasses which show differences in color. These differences can generally be attributed to differences in temperature distribution.

Because of these difficulties, each set of glasses was made up four times, and the crucibles were so placed in the furnace, that each glass was melted once in each of the four possible positions, making sixteen melts (four of each batch composition) in each group. The results were correlated by statistical methods which will be explained later. The meltings were carried out in a Fletcher type furnace, fired by natural gas and air, each crucible holding about a pound of glass.

In order to find out if the effects of the various substitutions were the same for different concentrations of selenium, three separate groups of glasses were made, the groups differing only in the selenium contents which were as follows:

Group I	0.010 per cent Se
Group II	0.015 per cent Se
Group III	0.020 per cent Se

The actual batches used are shown in Table II. It should be noted that the sulphate content of glass batches A, B, and C is the same, though it probably is not the same in the finished glasses due to variations in the amount volatilized. Experience had indicated that when SO_3 is introduced as barium sulphate, a greater percentage of the SO_3 remains in the glass than when it is introduced by the use of saltcake.

TABLE II

	A	B	C	D
Sand	200	198	200	200
Limestone	44	44	39	44
Soda Ash	78	78	80	80
Barium "C" Mix	...	...	4.0	...
Boric Acid	...	4.8	...	...
Salt Cake	2.0	2.0	...	...
Arsenic	0.5	0.5	0.5	0.5
Niter	2.0	2.0	2.0	2.0
*Se. Mix[1] [2]				

[1] *Se. Mix.—One per cent mixture of selenium in potter's flint.
[2] Selenium content was held constant in each series as follows, Series I, .010, Series II, .015, and Series III, .020

After being melted and rapidly cooled, all the glasses were found to be colorless, that is they were fairly well decolorized, but there was no assurance that all had received the same cooling treatment. To eliminate this variable, all the glasses were heated at one time to 1100° F in an annealing oven and cooled slowly to room temperature. After this reheating and annealing treatment, all of the glasses were colored pink.

To determine the relative color of each glass the samples were visually compared in sets of four, e.g., glasses A, B, C, and D were compared in each case with one another, and arranged in order of depth of pink color. In order to indicate this grading more readily, the lightest colored glass was designated as 1, and the deepest colored one as 4, those in between being classified as 2 and 3, where 3 is deeper in color than 1 or 2 but lighter than 4. No actual quantitative value is attached to these arbitrary numbers.

TABLE III. RESULTS OF TEST AFTER GRADING ACCORDING TO COLOR*

Group I (Se=0.010%)

Glasses	Position R	S	T	U
A—(Control with sulphate)	2	2	4	2
B—(Containing 1% B_2O_3)	1	3	3	1
C—(Containing 1% BaO)	4	4	2	4
D—(Control, no sulphate)	3	1	1	3

Group II (Se=0.015%)

Glasses	Position R	S	T	U
A—(Control with sulphate)	1	4	1	1
B—(Contains 1% B_2O_3)	3	1	3	2
C—(Contains 1% BaO)	4	3	4	4
D—(Control, no sulphate)	2	2	2	3

Group III (Se=0.020%)

Glasses	Position R	S	T	U
A—(Control with sulphate)	1	1	1	1
B—(Contains 1% B_2O_3)	2	3	3	2
C—(Contains 1% BaO)	4	4	2	4
D—(Control, no sulphate)	3	2	4	3

* In this table the four glasses (A, B, C, & D) are arranged according to their color rating and position in the furnace (R, S, T, or V). The intensity of color is designated by the figures 1 to 4 where 1 is the lightest in color and 4 deepest or pinkest color, 2 and 3 being in between. No quantitative value is attached to this color rating. For example, a rating of 3 merely means that the color of the glass is pinker than for one with a color rating of 2.

The results of this grading are given in Table III. To make the results clearer, the ratings for individual glasses have been assembled by type, and the number of times they receive a given rating is shown in Table IV as a percentage. According to this latter table, for example, glass A has a rating of 1, for 58.3 per cent of the cases. That is to say, in the twelve meltings of type A, this batch gave the lightest color in seven out of the twelve cases. In order to give each type of glass a numerical value based on its color, the very arbitrary method of multiplying the percentage by the rating was adopted. This method has no other purpose than to classify the glasses statistically on the basis of their color. This color evaluation is shown in the last column of Table IV.

TABLE IV

Glass	Color Rating 1	2	3	4	Color Evaluation
A—(Control with sulphate)	58.3%	26.0%	0.0%	16.7%	1.75
B—(Contains 1% B_2O_3)	25.0%	25.0%	50.0%	0.0%	2.25
C—(Contains 1% BaO)	0.0%	16.7%	8.3%	75.0%	3.61
D—(Control, no sulphate)	16.7%	33.3%	41.7%	8.3%	2.42

From the "color evaluation" in Table IV, the order of the glasses, in increasing pink color, is seen to be A, B, D, and C. This provides a means of determining the relative effect of the three ingredients, B_2O_3, BaO and SO_3 on the color.

A comparison of glasses A and D shows that the effect of sulphates, when neither B_2O_3 nor BaO is present, is to lower or decrease the color due to selenium. If, however, one per cent of B_2O_3 is substituted for one per cent SiO_2 in a glass containing sulphate, the color is improved to almost the same degree as for a glass free from sulphate and B_2O_3. If one per cent BaO is substituted for one per cent of the CaO in a sulphate-containing glass, the color is markedly deepened and the

color is deeper than for glass containing no sulphates.

From the experiments, the following conclusions may be drawn:

1. The effect of introducing sulphate into a glass containing selenium is to decrease the color from a given quantity of selenium.

2. The introduction of 1 per cent B_2O_3 into such a glass deepens the pink color just about enough to make up for the decrease due to sulphates.

3. The introduction of 1 per cent BaO into a sulphate-containing glass deepens the pink color to a greater extent than does B_2O_3.

4. The introduction of either BaO or B_2O_3 into a glass does not require an increase in selenium to maintain a given degree of decolorization. In fact, the selenium content generally will have to be reduced.

As is the case with all pot meltings or small scale experiments, the above conclusions can be applied to tank practice only when the conditions are the same in each instance. This is seldom the case. For example, the effect of changing the density of a glass by alteration of the lime, barium, boron or soda content is quite marked at the outset.

As a consequence, a composition change that increases the density of the glass, tends to bring up from the bottom of the tank, for a few days, glass that is low in color, and therefore, until this effect ceases, more decolorizer is required. Examples of such composition changes are the substitution of lime or barium for soda or silica, or to the substitution of soda for silica.

Conversely, a composition change that lowers the density of the glass tends to increase the surface flow of glass for a few days, and hence temporarily less decolorizer is required. Examples of such composition changes are the substitution of silica or boric oxide for soda or lime, or the substitution of soda for lime.

Care must therefore be taken in translating results from laboratory scale to commercial scale, to permit time for equilibrium to be obtained. Conclusions of the results obtained in tank practice should not be judged on the basis of the immediate effects in the dog-house, or in the ware. It is only after a tank has been operating consistently for some time after a batch change, that the conditions of flow of glass may be assumed to have reached a normal state. Too often these effects are overlooked in judging color effects in tank operation.

NAVIAS DESCRIBES RESEARCH DEVELOPMENTS TO ALFRED CERAMIC STUDENTS

About 150 people, both faculty and students at Alfred University, enjoyed the privilege of hearing Dr. Louis Navias speak on the subject of "Recent Developments in the Ceramic Field in both Europe and America." The occasion of Dr. Navias' talk was the first meeting of the student branch of the American Ceramic Society at the New York State College of Ceramics, Alfred.

In particular, Dr. Navias described the research work being done in the highly specialized field of sealing glass to metal and ceramic bodies. As an instance, he described a tiny high pressure mercury vapor lamp which is said to give twice as much light as a filament lamp for the same amount of current, and which is being developed for airplane, beacon and projection work. The problem is to seal the tungsten lead-in wires into the glass, the two materials having different coefficients of expansion. The difficulty here was solved by introducing various intermediate glasses into the lamp with coefficients of expansion varying from that of silica glass to tungsten.

Dr. Navias, who is well known for his work in silicate research, is a member of the research and development laboratories of the General Electric Co., and a very active participant in the affairs of the Glass Division of the American Ceramic Society. He recently returned from an extended trip in Europe following the International Congress on Glass. Dr. Navias reported to the Glass Division meeting at Cambridge Springs, Pa., this month on European research on glass. A report of this address will be found on page 369 of the current GLASS INDUSTRY.

SEPTEMBER PLATE GLASS PRODUCTION UP

The production of polished plate glass by members of the Plate Glass Manufacturers of America during the month of September, 1936, was 19,552,775 square feet as compared to 18,710,040 square feet produced in August, and 14,404,060 square feet produced in the corresponding month last year, September, 1935.

COMMITTEES FOR 1937 A. C. S. MEETING

Word of the appointment of committees for the 1937 annual American Ceramic Society convention, to be held at the Hotel Waldorf Astoria, New York, March 21-27, has been received. The members of the following committees were appointed by the New Jersey Ceramic Society, who are acting as hosts for the coming meeting. Committees with their memberships follow:

Executive Committee: Robert B. Sosman, *Honorary Chairman;* V. V. Kelsey, *General Chairman;* George H. Brown, Charles F. Geiger, Fred Sutterlin, Homer F. Staley.

Finance Committee: (This is a part of the Executive Committee). H. P. Smith, George Simcoe, in addition to the above.

Publicity and Public Relations Committee: E. V. Eskesen, D. P. Forst, Henry Kleinfeldt, Frank Valentine, C. F. Geiger, Harold Coss.

Exhibit Committee: D. William Scammell, Perry Helser, E. V. Eskesen, Paul Berryman, Martin Stangl, Leslie Brown, Frank Holmes, Arch M. Maddock, G. W. Jarman, Jr.

Meeting Service Committee: John Kauffman.

General Entertainment Committee: R. L. Clare, J. A. Williams, Ira Sproat, Jack Williams, Charles Brian, James Hamilton, Frank Dinsmore, Herreld Thropp.

Entertainment for Ladies Committee: (Includes the wives of the members of this Committee). Chester Treischel, J. M. Gilfillan, T. H. McKeown, D. William Scammell.

Sight-Seeing and Plant Visitation Committee: George Simcoe, Fred Whittaker, R. F. Sherwood, Harold Humphreys, George Crossley, William Kelley.

The Division of Simplified Practice of the National Bureau of Standards has announced that printed copies of Simplified Practice Recommendation R163-36, Coarse Aggregates (Crushed Stone, Gravel and Slag), are now available. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents each.

NOTES ON THE BACKGROUND OF HARDENED OR HEAT-TREATED GLASS

● Many patents have been issued on hardened or toughened glass. None of them get very far away from De La Bastie's original idea. Back in 1879, De La Bastie's Process was published and many of the extracts here quoted are taken from that publication. The inventor De La Bastie acted on the assumption that the fragility of glass proceeds from the weakness of the cohesion of its molecules, and that if the molecules could be forced close together, thus rendering the mass more compact, the strength of the material would be increased. His early experiments were tried while the glass was in a fluid condition. These results did not prove to be very interesting. He then changed his mode or working and commenced to apply a means of tempering the glass. He tried cooling the heated glass in oil immersion.

● De La Bastie endeavored to diminish the strain and deepen the extent of the case hardening and tempering the glass in a fluid other than water. None of the existing patents seem to say much other than La Bastie stated, "that the glass must be brought to just that degree of heat or softness of malleability begins, the molecules then being capable of closing suddenly together, condensing the material when it is plunged in a liquid at a considerably lower temperature." In carrying out the process, it is necessary that the glass to be tempered should be raised to a very high temperature; the hotter it is the less risk of breaking the glass. The necessity of heating the glass to the point of softening often added difficulties because sheets readily got out of shape. It was necessary to plunge almost without touching it. The danger of the liquid catching fire was very great. In some of the writer's early experiments, the bath often caught fire.

● It was found that articles made of thin glass could be plunged at lower temperature. Although the best effect produced in all glasses that were plunged in soft condition, yet with thin glass a high degree of tenacity was attained after it was plunged even while still hard. It was also found that instead of effecting the tempering by one operation of plunging, the article might be plunged several times consecutively in order to give it greater hardness. Sometimes the baths were either the same, or of a different character. Often a bath of hot oil was used on the first plunge, while on the second it might have been plunged into cold or warm water.

● The furnaces employed for carrying out the process of tempering flat sheet glass was rather complicated.

● To keep down the scum or crust that might attach itself to the glass surfaces, the liquid in the bath was constantly being skimmed. It consisted of a blade working by an external handle so as to push scum along a curved plate into a small wire basket. It was necessary to keep the liquid to a required level.

● It was found that small articles such as dishes, cups and the like might be heated in refractive molds so as not to spoil their shapes. By inverting these molds, the article could be dropped into the bath without much danger of destroying the contour.

● The applications of the tempered or hardened glass are limited by its peculiar properties. It cannot be cut with a diamond, and if the outer cuticle is fairly cut through the whole mass distintegrates. Here is where the writer disagrees. Really modern supertoughed heat treated glass will yield to certain points of fabrication. Circles have been cut out of heat treated glass sheets; holes have been drilled through with diamonds, and sheets have been cut in half with a knife edged grinding wheel.

● The article from which these extracts have been made also quotes H. J. Powell, of the Whitefriars Glass Works. "After a rough trial of this process, which certainly answers well for flat or solid glass, we decided that it is defective for hollow flint glass, since hollow vessels, if left to themselves in a kiln, are almost certain to collapse on reaching the required heat.

● The general fabrication of heat treated glass is too difficult for an ordinary mass production job. One of the last paragraphs of this article states, "Moreover, setting aside these difficulties, we come to a point which applies equally to all kinds of hardened glass. Hardened glass is not unbreakable; it is only harder than ordinary glass, and though it undoubtedly stands rough usage better, it has the disadvantage of being utterly disintegrated as soon as it receives the slightest fracture, and up to the present time of being undistinguishable from ordinary glass.

● Since this article appeared in Lippencott's Encyclopedia, published in 1879, various experiments have been made, a great many leading to the point where the glass became very hard and very brittle; whereas, other research workers have gone along the line of toughening the glass and avoiding the brittle point.

A SWEDISH GLASS PLANT

Snuggling in the midst of a southern Swedish forest in Orrefors—solely a glass works, not even a town.—Photo by courtesy of American-Swedish News Exchange, Inc.

THE PHYSICIST IN THE GLASS INDUSTRY

By E. C. SULLIVAN

Corning Glass Works

THE useful properties of glass, aside from its resistance to weathering and to other chemical attack, are physical* and many glass manufacturing problems lie in the domain of the physicist. So to a chemist organizing research for a glass manufacturer it soon becomes obvious that while there is plenty of work to be done in the chemical field his problems are in great measure problems which require training in physics. Although glass-making is classed as a chemical industry our own comparatively small development staff has about twice as many physicists as chemists. Also we have physicists outside the development organization, one being manager of a sales division and another a vice president of the company.

The physicist's most useful preparation for glass manufacture we believe to be training in the fundamentals of physics and in research, without specialization either in molecular physics at one extreme or in glass at the other. In our experience a man of proven ability to carry on high-grade research is most likely to be successful in manufacturing, whether in the plant or in the development department. Of course, in speaking of industrial physicists we have tacitly distinguished between those physicists on the one hand who are called engineers, who build on the basis of experience, and those on the other hand whom we call industrial physicists, who are more concerned with fundamental principles, who experiment to get new facts or who build on the basis of less familiar phases of the science of physics. The engineer has long since established his value to industry. The value of the industrial physicist has been recognized more recently.

The industrial physicist in a glass factory acts as a consultant and has furthermore three specific functions: first, to keep a watchful eye on quality of product, second, to improve manufacturing methods, and third, to develop new products. These functions overlap and I shall make no serious effort to separate them in this discussion. As a consultant in legal and patent matters he advises on endless variety of manufacturing problems. Taking one phase of manufacturing as an example, the continuous glass-melting tank is an inefficient, box-like structure which receives at one end raw materials and delivers at the other end molten glass. The physicist has traced out the course of convection currents in the glass which tend to mix partially melted material with that completely melted and thus slow up the melting operation, and has shown how proper temperature distribution over the glass surface helps in cutting down such mixing. If the glass is "specky" with gas bubbles which have not been expelled in the melting or if it is "stony" with bits of undissolved sand or refractories or crystallized material, the physicist is the consultant of last resort. Vital questions in glass melting obviously in the sphere of the physicist are the transparency of molten glass to radiation, radiating power of luminous and non-luminous flames, rate of expulsion of gas bubbles as related to size of bubble and viscosity of glass and therefore to temperature of glass.

To take another example, when a glass building block is under consideration, the physicist is asked for information on transmission of light, heat and sound, on condensation of moisture, on load resistance, wind resistance, fire resistance. He must work out a surface design of pleasing appearance, which will reflect the desired amount of incoming light and heat, which will diffuse sunlight and sufficiently obscure vision. Or, with a window glass which absorbs radiant heat he is asked how much air-conditioning energy will be saved in summer. He is asked about the design of an endless variety of objects, from bottles to glass-melting tanks, from radio tubes to lenses for airport beacons.

In standing guard over the quality of product the physicist sets standards, works out suitable rapid measurements and supervises the carrying out of such measurements. The property to which a certain glass owes its characteristic usefulness or the property which best serves as a check on the uniformity from one melt to another is measured constantly.

By way of illustration, the electrical resistance of some glasses is quite sensitive to variation in composition. Now the wires which supply current to an electric lamp or radio tube are carried from outside through a short length of glass tubing into which they are sealed. Unless the tubing has high electrical resistance the current will short-circuit through the glass from one leading-in wire to the other instead of passing through the filament. It is necessary to check constantly on the resistance of this so-called stem tubing.

The softening point, really a viscosity measurement, gives a good check on the uniformity of a given glass as melted from day to day and is important in itself in the case, for instance, of a glass for electric lamp bulbs, into which tubing is to be sealed on automatic lamp making machines which require the glass to soften always to the same extent in a fixed flame.

The thermal expansion-coeffiicent must be watched in glasses through which wires leading in to a lamp are sealed and to which also the bulb of different glass must be sealed. Thermal expansion is of vital significance in glasses for laboratory ware which must withstand severe temperature changes. Other measurements cover a very wide range of the properties which make glass useful and the total runs into many thousand in the course of a year.

With all its good qualities glass will break and it does happen that the user is inclined to lay the responsibility for breakage on the manufacturer. It is to the advantage of all concerned to get at the facts and here again the physicist steps in and from examination of the fracture, the condition of the surface and the pattern in polarized light tells us whether the article has had much use and whether it broke from a blow or from

*From a paper delivered before the anniversary meeting of the American Institute of Physics. Participating in this meeting were the Optical Society of America, American Physical Society, Acoustical Society of America, Society of Rheology, American Association of Physics Teachers. The joint meeting was held at the Hotel Pennsylvania, New York, Oct. 29-31.

internal pressure or from extreme heating or cooling, and frequently can suggest modifications in design or in the way the glass is used which will obviate future difficulty.

PERHAPS the first instance of routine high-temperature measurement on a large scale occurred some 30 years ago when a physicist installed platinum platinum-rhodium thermocouples in glass furnaces. Though the firemen had been skillful, temperatures had fluctuated between heat on the one hand which softened and destroyed the pots in which the glass was being melted, and insufficient heat on the other hand to melt the glass properly. In either case losses had been serious and there was uncertainty in scheduling production. The temperature-measuring equipment brought about immediately substantial increase in productivity of the furnaces.

The physicist in collaboration with the chemist plays a necessary part in glass composition development. What glass will best serve a given purpose is in the end determined by performance in actual use, but it is neither feasible to subject thousands of experimental glasses to service tests nor are such tests sensitive enough to detect slight differences which show whether an experimental composition change is in the right direction. It is necessary, therefore, to proceed by measurement of physical properties of experimental glasses with such service checks as are practicable.

The development of a glass of low thermal expansion, for instance, is not a matter of plotting a few points on a curve because not only the expansion-coefficient must be considered but at least half a dozen other factors as well as temperature required for melting, viscosity-temperature relationship or workability, tendency to devitrify, resistance to attack by water and other reagents, color, cost, volatility of batch constituents, and others. The approach to the desired glass, therefore, is gradual, by a series of advances and side movements and frequently retreats. A change in composition which lowers expansion may result in too high melting temperature. From such composition a side movement may be made in the hope of lowering the melting temperature without raising the expansion, or it may be necessary to retrace our steps and try to advance to the low expansion by another route that will not lead also to the high melting temperature. Every step of the way, accurate measurements on the part of the physicist are necessary because for further guidance we must express in figures just what a certain change in composition has gained for us, for example, in expansion and lost in meltability or other qualities. These and other physical measurements may become in large part routine but the devising of simple methods and the supervision of their carrying out to give results that can be depended on are far from routine.

Thus the physicist played an essential part in such developments as that of a glass for incandescent lamp bulbs which reproduced the properties of the lead glass formerly used and yet lent itself to tank melting and thus making possible modern continuous automatic bulb production which superseded intermittent melting and hand-working in pot furnaces.

The redesign of railway semaphore lenses and standardization of railway signal colors afford another example of the activity of the physicist in creating new products out of old. Each railroad had independently adopted a set of colors and no two reds or greens or yellows were exactly alike. An orange-yellow signal might be mistaken for red, or, more serious, a pale red might be mistaken for yellow. The situation was unsatisfactory from the standpoint both of railroad operation and of glass manufacture. The glasses now standard on the railroads of the United States and some foreign countries were chosen from two points of view: first, that the colors be as distinctive as possible, the red, for instance, well removed from yellow, the yellow neither too green nor too red; second, that the maximum percentage of light from the light source be transmitted. The physicist, furthermore, by redesigning the lens on the basis of the actual shape and size of the flame rather than on the basis of the theoretical point source of light doubled the distance at which the signal could be seen. The manufacture of signal glasses must be supervised by the physicist. A sample of each melt subjected to photometric measurement if not falling within definite limits both as to color and as to transmission causes rejection of the pot. After manufacture each piece of colored railway signal glass is measured photometrically.

Another direction in which the glass physicist has served the railroad is in lantern globes to withstand rapid heating and cooling, so that when the glass in a lighted lantern is chilled by rain or snow it will not crack and fail the trainman at a critical moment. The best glasses from this point of view are in general those which change volume least when heated or cooled and the physicist's accurate measurement of such volume changes in experimental glasses was a necessary part of the development.

Produced in this country for railroad use, glasses of low expansion have found wider application in other fields. Chemical beakers, flasks and apparatus in general, equipment for chemical manufacture, telephone and power line insulators, dishes for household use in the kitchen and on the table and miscellaneous ware constitute a business which scarcely could have been built up without the aid of the physicist.

For glasses of special electrical properties the physicist has developed large-volume commercial applications. His measurements of dielectric strength have led to the marketing of glass insulators of both pin and suspension type, for power lines, and he has demonstrated that they offer definite advantages. With his fellow physicist, the electrical engineer, he has improved insulator design to produce strength hitherto unequalled. Similarly he has brought about large-scale use for transcontinental telephone line insulation of a glass having unusually low dielectric loss. Such glass has been introduced also into insulation for radio sending and receiving sets.

The work of the physicist was indispensable in originating glasses aside from the railroad signal glasses already mentioned, either for filtering out or for transmitting specific bands of the visible spectrum or the invisible spectrum from X-rays to heat rays. Here the physicist and chemist must work closely together, the physicist measuring by various means the energy absorbed or transmitted in the wave-lengths of interest for the specific purpose, while the chemist selects batch mixtures which give not only appropriate filters for the

radiated energy but also glasses workable and resistant to weathering and satisfactory in other respects.

SUCH, for instance, are the glass used by physicians and dentists and others for protection against X-rays and on the other hand glasses for effective transmission of X-rays. Other glasses either transmit ultraviolet excellently, some as well as pure silica glass, or, like the glass used in so-called Sunlight lamps, transmit the therapeutic wave-lengths only. Other special glasses transmit only invisible ultraviolet, absorbing all visible light, and are used with fluorescent materials to produce weird stage effects.

A glass has been produced which while clear and almost colorless transmits practically all the visible light but absorbs practically all invisible heat rays. Another glass lets through no visible light but is fairly transparent to infra-red. For air-conditioning there are glasses which while cutting out the glare of the sun as well as most of its heat have low expansion to prevent their breaking as their temperature rises from the absorbed energy. There are glasses which with the incandescent lamp will give you the color of whichever of the several varieties of sunlight you wish: direct sun, northern sky or overcast sky.

In the recent seemingly magical art of drawing fibres and weaving textiles of glass the physicist is playing an indispensible part. He makes constant checks of the heat-insulating value of the material. He has reason to think his meaurements of electric resistance will demonstrate that the gossamer fibre woven into the proper fabric has merit as an insulating material for electric wire and cable. He has already demonstrated that these fibres, a few ten thousandths inch in diameter, have a tensile strength sometimes as great as a million pounds per square inch, greater than that of steel. He knows, therefore, that glass intrinsically is a fairly robust substance and he may be pardoned for dreaming of the day when he can incorporate its full strength into ordinary glassware and so approach the perfect form of matter.

Under the sponsorship of the physicist heat treatment of glass is assuming increased practical importance. Annealing, required to prevent stresses which might cause spontaneous breakage, was a haphazard process, wasting time and fuel and causing loss of ware either by breakage because of too little heat or by melting down because of too much heat, until the physicists worked out formulas for temperatures and rate of cooling.

As with steel, so with glass, heat treatment affects the physical properties. This discovery, made some twenty years ago by the physicist, only recently has been more fully grasped. Actually the extremely viscous nature of glass tends to slow up or stop altogether the internal rearrangements which normally are caused by change in temperature. As you cool water, say from boiling to room temperature, you increase the density. The change in density takes place with the change in temperature. Glass, however, is such a sluggish liquid—if it is a liquid—that the changes in density and other properties require time, and if it is cooled fast to ordinary temperatures, at which it ceases to flow, the density and other properties are caught in the process of changing and the high temperature values are so to speak frozen into the cold glass. It is as if you could cool molasses to its proverbial January temperature and still keep it as freely flowing as say in March. Very slow cooling, on the other hand, enables the internal rearrangement to keep pace with the temperature change and thus produces the normal properties in the cooled glass. It is, therefore, possible to have two glasses of identical chemical composition, one cooled rapidly and one slowly, both free from elastic strain and yet differing by several tenths of a per cent in physical properties. This discovery throws light on difficulties encountered in accurately reproducing a glass and points out the remedy. To control properly the refractive index of optical glass, for instance, the heat treatment must be precisely specified.

PHYSICS has been applied in heat treatment of another kind to increase the strength of glass. In the city of Paris today, your taxicab is equipped with heat-treated safety glass windows, not double sheets with plastic layers between as in this country, but a single sheet which will withstand four or five times as hard a blow as ordinary glass of the same thickness and which when it does break goes into harmless fragments the size of the end of your finger rather than into sharp jagged splinters.

To get this result the sheets are heated and suspended before a multitude of fine air jets. The surface layer of the glass is thus thrown under compression and the interior under tension. The tensile strength of the sheet is increased by the amount of the surface compression—for a force tending to stretch the glass must first overcome such compression—and it is tensile strength which ordinarily determines whether or not glass will break. It is very strong in compression.

Glass frying pans in which ham and eggs, griddle cakes, fried potatoes or any of the ordinary products of the oldtime skillet can be prepared are a recent development in which the physicists have played an indispensable role. Glass saucepans, double boilers, as well as skillets of thick glass can be used directly over the gas flame or electric heater. Combining the necessary physical properties the physicists have solved a most delicate and difficult problem.

PERHAPS the most outstanding contribution of all time to the problem of refractories has been made by the industrial physicist and he has established incidentally a flourishing industry. The container in which glass is melted on a large scale is built of blocks 12 inches thick up to two to three feet long and wide, put together very much as a child would build an open box of toy blocks. The rather porous clay blocks dissolved in the molten glass and where the attack was most severe, especially at the upper surface of the glass, it was only a matter of months before they were eaten down to a thin shell. Each year production was interrupted for a period of weeks in order to cool down the tank and replace the old blocks. At times the molten glass would break through without warning, causing an unplanned shutdown which entirely upset manufacturing schedules.

Certain crystalline compounds of silica and alumina ware, however, known to be resistant to glass attack and the industrial physicist's idea of making tank blocks was

to melt such silicates in an electric furnace and to cast the melt into a mold, very much as a casting is poured in an iron foundry. The product is a dense, crystalline material two or three times as resistant to glass attack as the clay block and capable of withstanding higher temperatures without softening. It has prolonged the life of the tank, has vastly raised average glass quality by eliminating streaks and striae which had been caused by the clay of the blocks and has increased productive capacity through the more rapid melting of glass brought about by higher operating temperature. Melting cost and repair cost per ton of glass are reduced and because more ware is obtained from a given number of tanks the required capital investment is less. The glass manufacturer has demonstrated his appreciation by steadily increased buying of the new block during the depression, and in 1935, barely seven years after the blocks were first offered to the public, of 250 glass tanks in operation in the United States only 20 were entirely without the new material.

The production of the disk for the mirror of the large California Institute of Technology telescope, an achievement in glassmaking which recently attracted public attention, was almost entirely the work of the physicist once the chemist had provided the proper glass formula. It was a task which involved pioneering at every stage. An object of unprecedented size in glass, a disk some 17 feet across and 27 inches thick, weighing 20 tons, flat on one side and with ribs on the other, was to be formed of a lower expansion borosilicate glass than any in commercial use, and was to be annealed as perfectly as the objective in a microscope. There was no established method of melting such a glass for such a purpose, nor, having melted it, of giving it the form of a ribbed disk. Should it be allowed to solidify in the tank in which it was melted and cut to shape when cold, or should the hot glass flow into a mold, or should it be ladled into a mold? There was no material recognized as suitable for the mold. And so at every step special and safe methods had to be devised and special equipment designed.

How the problems were solved has been told by others. The only point now is that where failure in any one of dozens of details of planning or execution might have wrecked the enterprise at the cost of a small fortune financially and a heart-breaking delay, the project was carried through successfully by the skill and ingenuity and courage of the industrial physicist. By no means all of the difficulties encountered were problems in physics but they were all incidental to an undertaking for which no one could be better prepared than the physicist, and they illustrate well the kind of accomplishment for which the right physicist may safely be called upon.

Aside from these very practical matters with which the physicists are engaged they are at work also on purely scientific problems in connection with glass, the solution of which, we are convinced, in the end will be no less fruitful than effort applied directly today to manufacturing methods or to products.

ENGINEERING IN EUROPEAN GLASS PLANTS

(*Concluded from page* 374)

was tried by the Crown Cork and Seal Co., or the General Electric scheme tried by the Fairmount Glass Co., and others in this country. Most manufacturers I saw expressed more interest in making a very superior bottle or article without any radical experimentation, with the production method having a fairly low operating cost. Electricity is not the cheapest heating medium even in Europe, not to mention the numerous difficulties one would experience by using it in trying to obtain clear constant uniform color glass articles in this manufacture over that of producing sodium silicate electrically or of producing glass by conventional fuel fired methods.

A great desire for sheet glass manufacture seems to predominate in most countries not only for the building boom everyone is experiencing but also for automobiles.

Advertising by decorating the neck of milk bottles is one scheme or form American manufacturers have not resorted to, especially manufacturers of dairy products such as milk, cheese, etc.

American plants seem to use more paper cartons and less wooden crates than European manufacturers that were contacted. I failed to find any air conditioned offices or plants that I visited in my travels through Europe. In a visit to Oklahoma plants during the past summer one could see crude forms of air conditioning used, which gave satisfactory results.

What we have to-day may be outmoded to-morrow, but that is as it should be for American ceramic progress marches on.

THE NEW OWENS-ILLINOIS CORRUGATED CONTAINER PLANT

Scientific interior layout of the corrugated container factory and warehouse recently completed by The Austin Co. for Owens-Illinois Glass Co. at Gas City, Ind., is suggested by the functional arrangement of more than 42,000 glass bricks in panels. Eight huge horizontal panels extending along the 541 foot east wall admit abundant glareless daylight all along the corrugating and box production line which occupies the second floor. The panels, 61-ft. 5-in. wide and 8-ft. 7-in. high, are the largest independent exterior sections to be constructed of glass brick up to the present time. The lower course of small horizontal panels, situated at ceiling height throughout the bottle warehousing area, which extends the full length of the first floor, are arranged to admit necessary light in the storage area. Glass brick recessed in three towering shafts on the North elevation affords illumination for stairway and lobby.

THE BELGIAN GLASS INDUSTRY—1935

By THOMAS L. HUGHES

American Commercial Attache at Brussels

THE[1] manufacture of glass is one of Belgium's oldest industries, having been started at the end of the 16th century by Venetian and Verona artisans in the Liege district. Development of the industry was rapid and by the middle of the 17th century Belgian glass was competing with the Italian product on export markets, though the principal products at that time were table ware and bottles. In 1643 coal was used instead of charcoal in the process and the industry extended to the Charleroi district, while in the Liege area the industry was on the decline. The making of window glass was also started about this period, but the manufacture of crystal is of more recent date since it was begun only in 1764 at Namur. A plant established near Givet about 1825 was the origin of the famous Cristalleries du Val-Saint-Lambert in Belgium and Baccarat in France, and the manufacture of plate glass began in Belgium at Aiseau in 1836.

Toward the middle of the 19th century the Belgian glass industry occupied a prominent position in world markets and, with the exception of the bottle factories, all the glass plants experienced great prosperity. Nine-tenths of the production were usually exported. Exports in 1850 were estimated at 16 million gold francs, and in 1880 at 50 million gold francs. At the beginning of the present century, Belgium, which was second only to Germany in the production of glass, exported 95 per cent of her production estimated at 40 million square meters, mostly to France, England, Japan, the United States, Brazil, Argentina and China. In 1913, Belgium occupied second place only to Germany in world exports as regards value, 85 million gold francs as compared with 146 million francs worth exported by Germany.

The Belgian glass industry experienced its first crisis in 1904-5 when mechanical window glass plants were started in the United States. Exports fell off and it was believed that the Belgian blown-glass plants would be reduced to the manufacture of thin glass, table ware and crystal. In 1911 a mission was sent to the United States to study new methods, although a few years previously two engineers, Gobbe and Fourcault, had already started research work with a view to producing cheaper window glass. The Fourcault mechanical glass process was invented and was the beginning of the transformation of the Belgian window industry after the World War.

The 1930 census for the whole of the Belgian glass industry indicates that 28,505 workmen were registered, or 1.79 per cent of the total number of industrial workmen in the country. This number comprised 22,823 men and 5,682 women.

A bill was presented to parliament in 1935, with a view to establishing a four-shift system in the window glass plants. The purpose of this measure is to enforce the proposition adopted by the International Labor Conference, and would result in the establishment of an average week not to exceed 42 hours, which, in effect, would mean added labor costs and wages in some of the glass factories. In the window and plate glass plants wages were increased 2.5 per cent in Oct. and 2.5 per cent in Nov. 1935. In the table ware works a 5 per cent increase was granted in June 1935 with a further increase of 5 per cent in Dec. 1935.

Wages are regulated by the fluctuations in the cost of living index number. They vary according to the worker's age and number of years of employment. For skilled labor a wage of from 5 to 6 francs an hour is paid, while ordinary workers earn from 4 to 4.50 francs an hour.

Window Glass

BEFORE the World War there existed 24 plants with 39 furnaces, of which 27 were generally active, 10 idle and 2 kept in reserve. The production of these plants consisted entirely of blown glass, since among the idle furnaces were those of the only two mechanical plants then in existence, i.e., the Ste. Ame. des Verreries de Dampremy (Fourcault process) and the Ste. Ame. pour la Fabrication Mecanique de Verre en Feuilles (Rowart process) which did not meet with success. The pre-war production of blown glass reached a yearly average of around 49 million square yards.

After the War the glass plants started work very soon, the demand for glass being, of course, very considerable and pressing for the devastated areas. Heavy production set in and prices were remunerative. However, when the local demand was satisfied it soon became obvious that work and sales conditions had undergone material changes, and that an industry which relied on the export market for most of its sales was confronted with new problems on the world markets.

The United States and Japan, which were among the best clients of the Belgian plants, had considerably extended their glass industry during the War and were now competing against their former suppliers in the Far Eastern and South American markets, and even in Europe, and, at the same time, employing measures to keep their domestic markets for themselves. Furthermore, monetary difficulties and high duties did not contribute to business activity in many countries, and in Belgium itself such trade barriers and the growing scarcity of skilled labor confronted the plants that several were forced to close down. The necessity for reorganization became pressing and efforts to keep pace with technical progress were imperative when, in 1921, the Libbey-Owens Sheet Glass Company decided to start production in Europe. A Libbey-Owens plant was established at Gompel in the Campine district under the title Compagnie Internationale pour la Fabrication Mecanique du Verre. Actual production began in April 1923 and the new glass soon found its way in the Belgian, as well as export markets. The Fourcault plant had started production a year previously at Dampremy and a small amount of mechanical glass had been sold. From the beginning progress was rapid and the Belgian plants found it advantageous to adopt the Fourcault process.

In 1925 there were already five plants producing

[1] This paper was released through the courtesy of the Specialties Division, Bureau of Foreign and Domestic Commerce.

mechanical glass and nine in 1929, plus five plants which used the mechanical process and still produced blown glass. The ratio of mechanical production to the total window glass production was as follows: 1923, 13.7 per cent; 1925, 36.1 per cent; 1927, 68.0 per cent.

In 1930 a third process made its appearance in Belgium; the "Pittsburgh process" adopted by the Verreries de Zeebrugge. At that time the mechanical plants numbered 13, with 181 drawing machines having a total yearly capacity of 70 million square meters of window glass.

These new processes have supplanted the old blown method to an extent that, except for certain special kinds of glass such as colored or very thin glass, it has been practically abandoned. The technical changes for the improvement of the industry had been effected without interruption and progress was being made when in 1929-30 the world depression set in, with the consequent shrinkage of export markets. It was soon found that concentration in production offered the best solution to the problem of decreased exports, and the Fourcault plants, which already had a common sales organization, amalgamated in 1930 under the name of "Union des Verreries Mecaniques Belges" and capitalized at 200 million francs. The new outfit comprised 13 plants with 18 tanks, or about 70 per cent of the total Belgian production. The number of tanks in activity was reduced to cope with the lesser demand, and the new organization also endeavored to reduce the stocks which weighed heavily on the markets.

In 1931 the Libbey-Owens plant "Compagnie Internationale pour la Fabrication Mecanique du Verre" amalgamated with several plate glass plants to form a concern called "Glaces et Verres" (Glaver) capitalized at 250 million francs. The production of the plants was centralized by Glaver and the old concerns became holding companies only.

In 1932 an agreement was concluded between the two groups and a cartel was formed to regulate sales on the domestic and export markets. The Belgian cartel has succeeded in making similar arrangements with foreign groups, notably the Czecho-Slovakian producers. During the course of 1935 two blown glass plants, which had been closed for some time and were not members of the Union des Verreries Mecaniques, started production with one tank and 6 drawing machines each. The Union started a price war against these outsiders to force them out of the market, but without success. Today the entire production of Belgian window glass is mechanical.

Raw Materials—The glass industry is one of the few Belgian industries which still find supplies of raw materials in the country itself. The necessary types of coal are found in the Borinage basin; sand is utilized from the great quantities available in the Campine; the lime is excavated in the surroundings of Mons; while sulphate of soda and potash is produced by Belgian chemical plants. Lumber for packing is imported, principally from Sweden and Norway.

Production—Before the War the Belgian production[2] of window glass was entirely confined to blown glass and therefore the bulk consisted of the thinnest kinds. The current categories manufactured were:

Thin glass	10 to 14 ounces per sq. foot
Single glass	14 to 18 ounces per sq. foot
One half double	21 to 26 ounces per sq. foot
Double glass	26 to 30 ounces per sq. foot
Triple glass	30 to 36 ounces per sq. foot

The plants also manufactured considerable quantities of photographic glass, ranging from thick, or 14 ounces per square foot, down to 5.4 ounces per square foot for extra thin. At present, photographic glass is also made by the mechanical process.

The quality of window glass was divided into five categories: First, second, third and fourth choice, and rejects, the latter being known as China quality. The bulk of the output consisted of thin and half-double, as the heavier dimensions were rare and expensive owing to the scarcity of skilled labor.

The transformation of the industry to the mechanical process allowed the easy manufacture of thick glass and at present the Libbey-Owens plant produces 4 mm. glass which competes with plate glass.

Foreign Trade—Belgian exports[3] of window glass reached a peak of 284,812 tons with a value of 671 million francs in 1929, but the foreign demand declined during the five subsequent years to reach the lowest point in 1933 with exports of only 106,110 tons valued at 205 million francs. Shipments began to increase in 1934 with 106,843 tons value at 210.9 million francs, and in 1935 amounted to 134,639 tons with a value of 227.4 million francs. During 1935 the United Kingdom, Holland and Canada were by far the most important buyers. Imports were negligible.

Outlook—The outlook for the Belgian window glass industry is not particularly bright, since the expansion of this industry in countries which were former clients of Belgium producers is hampering the activity of Belgian plants, as most countries shield their newborn or expanding industries by protective measures. Restrictions on transfer of funds as obtain in many countries have also caused a shrinkage of export possibilities. The window glass industry, which is now working at about 45 per cent capacity, will find it very difficult to open up new outlets which would warrant any considerable increase in production.

Plate Glass

THE first attempt at manufacturing plate glass in Belgium was made by Count de Lalaing with the aid of Emperor Charles V in 1541. However, the plate glass industry as such, started in the 18th century. In 1777, a glass plant was created at Voneche in which the owner wished to begin the manufacture of plate glass. In 1822 the King of the Netherlands promised to protect the plant against foreign competition but this protection could not be maintained, and the plant closed down after the revolution in 1830. It is not known whether plate glass was actually produced at Voneche.

In 1836 a plant was constructed by the Val St. Lambert company and production began in 1841. A second plant was built in 1853 at Floreffe, but the large expansion of the Belgian plate glass industry dates between 1870 and 1900. At the end of the World War all the plants ex-

[2] Detailed statistics on production may be obtained from the Specialties Division of the Bureau of Foreign and Domestic Commerce.

[3] Destination of exports by countries and values may be obtained from the Specialties Division, Bureau of Foreign and Domestic Commerce.

isting in 1914 resumed operations, and in 1926 a new plant was added at Moll by the Cie. Internationale pour la Fabrication du Verre (Libbey-Owens).

The general conditions of the markets and the capacity of the modern equipment immediately after the War caused the Belgian plants to concentrate their sales organization in a single unit under the title of Union Commerciale des Glaceries Belges, comprising 6 plants. Two firms remained out of the organization and handle their own sales, i.e., S.A. des Glaces de Courcelles (Pittsburgh Plate Glass Co. and S.A. Manufacture des Glaces et Produits Chimaques de Saint-Gobain, Chauny et Cirey. The Union Commerciale des Glaceries also handles the sales of the plate glass produced by the Glaver plants.

From 1923 to 1929 the Belgian plate glass plants passed through a period of great prosperity as they were called upon to supply a considerable proportion of the requirements of the American automobile manufacturers, since American plate glass plants were unable to satisfy the ever-growing demand. When the crisis set in and the new American equipment for supplying the American market was too extensive in proportion to the demand thus causing keen competition on the domestic market, the Belgian plate glass plants were seriously affected. They were forced to curtail output, as well as to reorganize in order to reduce their production costs. Since the Belgians were exporting on all world markets about 90 per cent of their production it was practically impossible to find new foreign outlets. However, close cooperation between the plants resulted in a fair activity being maintained at prices which were still remunerative.

The Belgian plants were among the signatories to the international convention of Aug. 17, 1904, to which French, Dutch, German, Austrian, and Italian plate glass plants were also party. This cartel, which now supervises production and regulates sales, is an example of efficient coordination and has succeeded in avoiding immobilization of stocks, important price fluctuations and speculation. The Belgian industry has a favored position in the international cartel since it is the largest producer as well as the largest exporter.

The plate glass industry is making efforts to recuperate lost markets by a more extensive use of plate glass and has succeeded in creating an interest among architects in using more and more plate glass in their modern construction. The industry is also applying to the Government for a reduction of fiscal and social charges, which at present are 35 times higher per square meter produced than in 1913 and offset the reductions in the cost of production resulting from technical improvements.

Three firms are now making special glass for automobiles: the Glaceries Reunies of Jemeppe-sur-Sambre, the Belgian Indestructo Glass Co. and the Splintex Belge. They manufacture non-shatterable glass by the cellulose acetate process and also hardened flexible glass.

Production—The current thickness of plate glass produced in Belgium varies from 6 to 8 millimeters, but glass is produced as thin as 3 millimeters and up to 9 millimeters or even more. Dimensions of the sheets may be as large as 6 x 3 meters, or 18.2 square meters. The maximum appears to be 8 x 4 meters or 32.2 square meters. The largest ever made was manufactured for the 1900 Paris Exhibition by the Cie. de Saint Gobain and measured 8.50 x 4.20 meters. The average measures are now influenced principally by the needs of the automobile industry. The production of plate glass over a number of years follows:

	Square Yards
1851	24,000
1906	3,000,000
1921-1925 (4 yr. average)	3,558,000
1926-1930 (4 yr. average)	4,075,000
1929	4,542,000
1930	2,921,000
1931	2,042,000
1932	1,874,000
1933	1,857,000
1934	1,828,000
1935	1,867,000

Foreign Trade—Imports of plate glass into Belgium are negligible compared to the large exports, which still represent practically 90 per cent of the production. During 1935 Belgian exports[4] of plate glass fell off considerably as compared with 1934 figures, total exports amounting to 262,544 metric quintals valued at 162.2 million francs, as against 291,659 metric quintals valued at 181 million francs. Reduction in exports to Japan, Italy, Egypt, and the United States, as well as to "other countries" is responsible for the decrease. Exports to Italy alone decreased from 11,734 metric quaintals to 3,878 metric quintals due to the measures taken by the Italians to avoid the exportation of gold.

Outlook—The excellent organization of the plate glass cartel has permitted this industry to withstand the world crisis in a very efficient manner. The ever-growing expansion of the automobile industry; the tendency in modern architecture to employ more and more plate glass in house-building and decoration, as well as in the building and transformation of shops; and the extensive use of plate glass and mirrors in ship decoration should sustain a satisfactory demand for plate glass for many years to come. The reduction in Belgian exports is decidedly counterbalanced by an appreciable increase in local consumption.

Miscellaneous Glass Ware

BELGIUM also possesses an important industry manufacturing all kinds of glass ware, the mere enumeration of which would require considerable space. There are some 30 factories, located principally in the Hainaut province, which manufacture these articles. These works are selling from 80 to 90 per cent of their products in foreign markets and normally provide employment for some 6,000 workers. The most important articles consist of table ware such as drinking glasses, goblets, tumblers, decanters, water jugs, finger bowls, cheese covers, sugar bowls, butter dishes, plates, etc. These are manufactured in a great number of qualities and designs in common glass or half-crystal.

The Belgian crystal and art glass industry is known the world over for its articles for table services and vases, and the largest concern in this line, the Cristalleries due Val St. Lambert, has a world-wide reputation for its cut crystals and colored crystals which have proven difficult to imitate. The Val St. Lambert works normally employs 5,000 workers and exports 90 per cent of its output.

The Belgian bottle industry is also an important fac-

[4] Comparative statistics of Belgian foreign trade in plate glass for the years 1934 and 1935 may be obtained from the Specialties Division of the Bureau of Foreign and Domestic Commerce.

tor in world markets. In 1929, for instance, exports of bottles, phials, flagons, demijohns, etc. amounted to 18 million francs while the total exports of glass ware exceeded 147 million francs.

There also exists an industry specializing in pressed glass for the building trade and ornamentation such as floor and roof tiles, etc.

Concentration in the glass ware industries was caused by the 1930 crisis, and in 1931 a cartel was formed grouping the most important producers in Belgium. The immediate result was the closing down of the least well-equipped factories with a view to reducing the production. Government protection was also obtained by the licensing of imports of foreign ware. This measure mostly affected Czecho-Slovakian and German dumping.

The bottle factories followed the example and created a sales comptoir grouping the four largest producers of the country.

The pressed glass manufacturers are also grouped into a sales organization for the limitation of production to prevent excessive accumulation of stocks.

All these groups have applied for government protection, mostly in the form of an appeal to the Council on Economic Litigation to enforce limits on production of all plants in the industry and to prevent the installation of new plants. Satisfaction was given in certain cases, such as the plants manufacturing blown glass ware and the glass container industry. A similar appeal by the pressed glass industry was rejected.

Among the art glass producers, the church window glass manufactures are outstanding, with some 23 small factories. Photographic plate glass is also manufactured and the exportation of sensitized photographic plates is very important, reaching from 10 to 15 million francs in value annually.

Outlook—The outlook for the miscellaneous glass industries of Belgium is not too bright, owing to the many difficulties encountered in the export markets on which these industries are mainly dependent. Aside from the fact that competition is very keen, the many trade barriers such as licensing systems, exchange restrictions, etc. render business very difficult. To meet this situation the cartels have reduced their production considerably and have devoted more attention to the local market than heretofore, but the home demand is too small to warrant the present equipment of the plants in the event that export possibilities are further reduced.

Trends in Foreign Trade

TOTAL exports in 1935 amounted to 547.6 million francs, or an increase of 21.5 millions over 1934 exports. The United Kingdom is by far the most important customer, though the 1935 total purchases amounting to 173.5 million francs were slightly lower, by 5.7 million francs, than the 1934 total. Holland, the next best client, increased total purchases from 34 to 40.5 million francs in 1935, followed by Canada whose purchases rose from 24 to approximately 34 million francs in 1935. Exports to the United States increased slightly from 6.2 to 7.6 million francs, while the value of exports to Italy was practically halved, falling from 13 millions in 1934 to 6.5 millions in 1935.

On the import side, the most important suppliers are Germany, Czecho-Slovakia and France, in order of importance. Germany sells in Belgium a considerable quantity of common glass ware, Czecho-Slovakia ships Bohemian crystal as well as common colored glass ware, while France supplies Baccarat crystal. However, compared to exports, the value of Belgian imports is very small, and was only 52 million francs in 1935, having increased by about 9 millions over the 1934 total.

[5] Detailed statistics showing quantity and value of individual items are on file in the Specialties Division, Bureau of Foreign and Domestic Commerce.

RESEARCH STAFF AT ALFRED ANNOUNCED

Dean M. E. Holmes of the New York State College of Ceramics, Alfred, N. Y., has announced the staff of the new ceramic experiment station to be, as follows:

Professor of Research. H. G. Schurecht. Professor Schurecht graduated in ceramics at the University of Illinois. Later did graduate work at Ohio State University and the University of Pittsburgh. He was ceramic chemist for the Findlay Clay Pot Co., 1914-1916; associate ceramic chemist, Bureau of Standards, 1916-1917; ceramic chemist, Ohio State University, 1917-1923; senior fellow, Vitrified Salt Glazed Sewer Pipe Fellowship, Mellon Institute, 1923-1925; senior research associate, National Terra Cotta Society Fellowship, National Bureau of Standards, 1925-1931; and chief chemist, Eastern Terra Cotta Co., 1931-1936. Professor Schurecht is a charter Fellow of the A. C. S., as well as a member of the English Ceramic Society, the German Ceramic Society, the American Chemical Society, and various honorary organizations. He has to his credit a long list of publications in technical journals and bulletins issued by the Bureau of Mines, The Bureau of Standards and The Geological survey of Maryland. He has also patented several ceramic processes, now in use by the industries.

Assistant Professor of Research. J. F. McMahon. Professor McMahon graduated from Alfred in 1923 and remained for one year as shop foreman in the Ceramic School. He was employed for one year as Ceramic Engineer for the Queens Run Refractory Co. He left Lock Haven to join the Ceramics and Road Materials Division of the Canadian Department of Mines at Ottawa, where he has remained until now. For the past eleven years Mr. McMahon has been engaged in the study of problems relating to the manufacture and use of ceramic products. Mr. McMahon is Vice-President of the Canadian Ceramic Society, a member of the American Ceramic Society and a member of Keramos Fraternity.

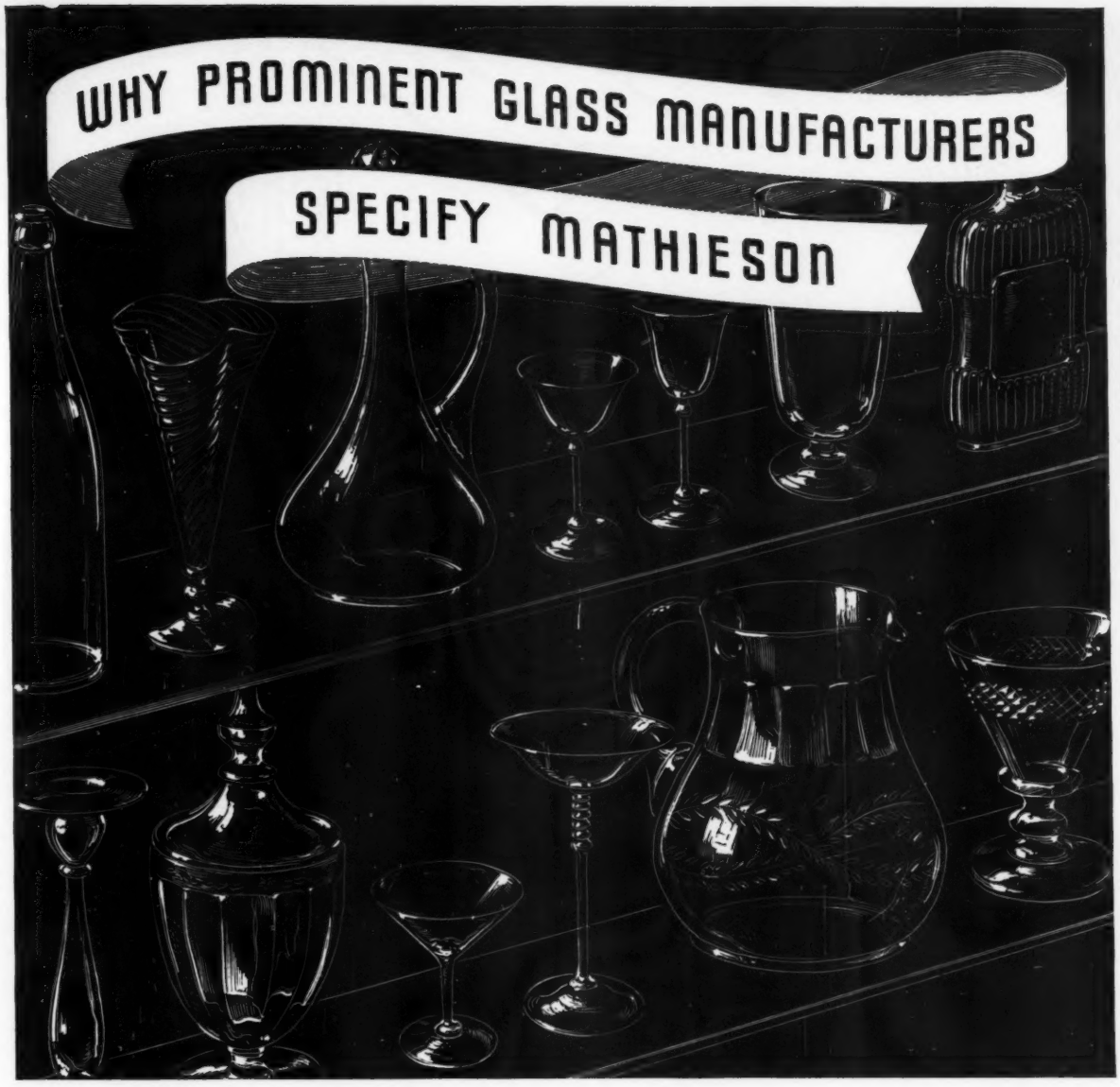
Assistant. Charles Major Lampman, Jr. Mr. Lampman graduated from the New York State College of Ceramics in June, 1936. His training and adaptation particularly fit him for research work.

3,400-YEAR EXHIBITION OF GLASS

A distinguished exhibition of art glass ranging from the domestic drinking bowls of the ancient Egyptians to the modern engraved crystal of present-day America will be on view at the Metropolitan Museum of Art, New York, until Nov. 29. Several hundreds of the finest glass vessels in the Museum have been selected to represent the different historical periods in the making of fine glassware.

Typical of the exhibit of "the history of glass" are a decorated Egyptian vase of molded glass; a jug signed by Ennion with molded relief decorations; a Chinese 18th century snuff bottle; a German 15th century drinking glass; a 16th century mosque lamp of Mamluk glass; a 16th century Tyrolese ewer; an 18th century New Jersey glass bowl and a modern Steuben glass vase designed by Sidney Waugh.

A special catalog has been prepared for the show and contains a historical survey of glass as well as illustrations of some of the pieces which have a part in an extremely interesting exhibit.



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EQUIPMENT AND SUPPLIES

A NEW PERFORATED PLATE

The Abbe Engineering Co., Inc., New York, have introduced a new BFS extra thick conical hole plate for pulverizers, hammer mills, filters, centrifugals, dryers, etc. The following advantages are claimed for this new plate: openings such as .01" to .02" may be supplied in all metals, including stainless steel; plate thicknesses may be supplied much greater than those usually available; and the conical shape of the holes is said to prevent blinding of the screen perforations. Further details may be otained from the company, located at 50 Church St., New York, by requesting their bulletin, AH-17.

CATALOGS RECEIVED

Handbook of Building Maintenance. Flexrock Co., 800 North Delaware Ave., Philadelphia, Pa. A technical booklet designed to assist the plant engineer on day to day building maintenance problems. It consists of 40 pages including more than 25 detailed mechanical drawings and more than 55 half tones and line cuts.

Baker's Analyzed Chemicals. J. T. Baker Chemical Co., Phillipsburg, N. J. A complete list of this 32-year old company's chemicals with an analysis and price given for each item.

American Dustube Dust Control. American Foundry Equipment Co., Mishawaka, Ind. The first half of this book is devoted to the applications of this equipment to dust control problems, while the second half is devoted to engineering data of interest to the technical man as well as the practical shop man.

Brown Air Operated Controllers. Catalog No. 8901. Brown Instrument Co., Philadelphia, Pa. A new fully illustrated catalog covering the complete line of Brown air operater controllers. The principles of operation, simplified construction, and interchangeability of control units are described in non-technical language.

Super-Stitch Boxmakers Wire. Chicago Steel & Wire Co., 103rd St. and Torrence Ave., Chicago. A description of this company's latest development in stitching wire, which is made in coppered, galvanized and tinned finishes.

Johns-Manville Industrial Products. Johns-Manville Corporation, 22 East 40th St., New York City. A profusely illustrated 60-page book giving information and recommendations on high and low temperature insulation for industrial needs. Among the new products described are a thin-walled form of asbestos-cement electrical conduit, a mineral insulation for low temperature piping and a non-impregnated asbestos-cement sheet for switchboard panels that will stand vibration and is immune to carbonization.

Things You Should Know about Your Roof. Johns-Manville Corporation, 22 East 40th St., New York. Presents the engineering data in connection with roofing as well as an analysis of some of the problems encountered and their remedies. Also gives information on paying for roofing work on time.

Link-Belt Stoker. No. 1619. Link-Belt Co., 307 North Michigan Ave., Chicago. Recently off the presses is a new 28-page book on automatic coal stokers for industrial and commercial uses in capacities up to 300 H. P. Copiously illustrated, the booklet reproduces letters from users and gives much pertinent data.

Bristol's Thermometers. Catalog No. 1250. *Bristol's Wide-Strip Pyrometers.* Catalog No. 1451. The Bristol Co., Waterbury, Conn. Two fully illustrated and amply diagrammed catalogs on instruments which are important to successful production.

PYROPHYLLITE

The United Feldspar Corporation has announced that, through its subsidiary, the Tennessee Mineral Products Corporation, it has concluded negotiations to acquire the entire capital stock of the Carolina Pyrophyllite Co., Staley, N. Car., who control what is said to be the largest known deposit of pyrophyllite in the United States.

This deposit of pyrophyllite was covered in a paper by B. C. Burgess, entitled "Pyrophyllite—a New Development," presented at the annual meeting of the American Ceramic Society in Columbus last Spring.

Regarding future plans, C. H. Peddrick, Jr., vice-president of United Feldspar, advises, "We now plan to erect a mill at or near these mines and will process the mineral under our chemical control patent No. 1,855,115 to produce a uniform quality of pyrophyllite according to specification. Construction of the plant will probably start within the next two months and should be completed some time in the Spring of 1937. At the present time, the pyrophyllite is being processed at the plant of the Tennessee Mineral Products Co., at Spruce Pine, N. Car., under patent No. 1,855,115 but construction of a plant at or near the mines will enable us to supply competitively all grades of pyrophyllite."

A NEW DUST COUNTER

Help in controlling the dust problem in plants is furnished by the new dust counter recently developed by the Bausch & Lomb Optical Co., Rochester, N. Y. The new counter combines in one unit, easily operated, both the necessary air sampling device and a dark field microscope viewing and counting system, mounted on a circular base, provided with illuminating apparatus and suitably cased for safe transportation and storage.

The sampling mechanism consists of a moistening chamber through which the air is drawn by means of an accurately calibrated hand pump of 1/1000 cubic foot capacity and an impinging device which deposits the dust particles suspended in the air on a circular glass plate within the instrument. The viewing and counting apparatus consists of a built-in compound microscope of 200 X magnification with a special dark field illuminating system. The microscope is fitted with a special Hyperplane eyepiece in which there is a micrometer disc ruled in 30 micron squares to be used for dust counting.

The apparatus is so calibrated that by multiplying the number of dust particles by 100,000, the total dust count per cubic foot is secured. The entire instrument is air tight to avoid chance deposits of dust. Both sampling and counting may be readily accomplished without interrupting factory routine. By means of a rubber bulb, the air moistening chamber is quickly cleared of any air left from previous sampling.

NEW ENGLAND OFFICE

A New England office, staffed for consulting and sales engineering service to those having problems of instrumentation in manufacturing processes, laboratories, power plants or educational institutions, has been opened recently in Boston by Leeds & Northrup Co. Their complete line of measuring, recording and controlling instruments, as well as their electric heat-treating furnaces, will be handled through this office, 80 Federal St., Boston, Mass.

M. W. North, formerly with Simplex Products Co., has been appointed office manager by Pyrometer Service & Supply Corporation of Cleveland.

As of October 1st the offices of Electro Bleaching Gas Co. and its affiliate, Niagara Alkali Company, were moved into new and more spacious quarters on the 30th floor of the Lincoln Building, 60 East 42nd St., New York.

USE OF POLAROID MAKES POSSIBLE NEW STRAIN DETECTOR

A new type of polariscope, called the "Strain Detector," has been announced by the Polarizing Instrument Co., 8 West 40th St., New York. It employs the principle of transmitted polarized light opposed to reflected light, for the detection of strain in glass, and provides the observer with a large area of inspection, of uniform darkness and at the same time an inexpensive apparatus that is small, compact, portable and one that is easily and quickly set up for use.

In the past, polarization by transmission has seldom been utilized in the glass industry because of the costliness of the apparatus and the fact that only comparatively small areas could be tested. Its present application is made possible by the use of "Polaroid," the new material of which so much has been heard lately.

The new "Strain Detector" is pictured in the accompanying illustration. The operator seats himself before it, and adjusts a telescopic arrangement at an angle most convenient for his vision. The viewing plate is adjustable from one to 15 inches, so that even very large objects may be interposed for examination. Seated in a comfortable, relaxed position, and without applying the eye to any small aperture, the observer looks through a viewing plate that is four inches in diameter. The full field of the object is seen with a high degree of uniformity.

The Strain Detector in short provides an instrument in the low price field for the examination of glass without any sacrifice of efficiency, adds a new element of convenience and flexibility. The Polarizing Instrument Co. suggests that this equipment is of use to the following: bottle manufacturers, plate glass manufacturers, lamp and tube makers, radio manufacturers and for various special applications such as the examination of resinous products, etc. Strains may be detected not only in clear but in colored or semi-transparent glass.

The Strain Detector was on view in New York on Oct. 29-31 at the Anniversary meeting of the American Institute of Physics. It attracted widespread attention, and a number of glass men stopped in to inspect it.

Also on view was the Polaroid Strainscope which operates on the same general principle as the Strain Detector, but is smaller in size. It weighs less than two pounds, is only seven inches long and works on 110 volts AC or DC. The Strainscope gives a clear field of 42 mm., and is equipped with a rotating eyepiece.

● The new Strain Detector which was exhibited at the American Institute of Physics anniversary meeting last month. The development of Polaroid has made possible this practical instrument for testing glass of varied sizes. The makers of this apparatus, the Polarizing Instrument Co., New York, believe that because of its inexpensiveness and efficiency, Strain Detector and the smaller Strainoscope will find acceptance.

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Chrome Oxide Green
Cobalt Oxide Black
Copper Carbonate
Copper Oxides
Glass Decolorizers
Iron Chromate
Iron Oxides
Iron Sulphide
Lead Chromates
Lepidolite
Manganese Carbonate
Manganese Dioxide
Magnesium Carbonate
Neodymium Oxalate
Nickel Carbonate
Nickel Oxides
Nickel Sulphate
Polishing Rouges
Potassium Bichromate
Potassium Carbonate
Potassium Chromate
Powder Blue
Putty Powders
Rutile Powdered
Selenium
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Sodium Silico Fluoride
Sodium Uranate
Titanium Oxide
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		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.15
52% and 48%	lb.	.10	.12½-.11½
Nitric (HNO_3) 130 lb. carboy ext. Per 100 lb.		...	5.50
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	...	Po. or Gr. .25 / Cry. .25½
Aluminum hydrate (Al (OH)$_3$)	lb.	.04-.04½	.04½-.05
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Ammonium bicarbonate (f.o.b. works)	lb.	.0515	...
(f.o.b. N. Y.)	lb.	...	.0571
Ammonium bifluoride (NH_4FHF)	lb.	...	.15
Ammonium nitrate (NH_4NO_3)	lb.	...	.08
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¾
Antimonate of Sodium	lb.	.12	.12½
Antimony oxide (Sb_2O_3)	lb.	...	.12¾
Antimony sulphide (Sb_2S_3)	lb.	...	.13
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03½	.04-.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	40.00	45.00
90% through 100 mesh	ton	38.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	.0475	.05¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¾
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
(Commercial, 25% Selenium)	lb.	...	.90
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Bone ash	lb.	.06	.0625
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.022	.0245-.027
Powdered	In bags, lb.	.0245	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.05	.0525-.055
Cadmium sulphide (CdS)—	lb.	...	.90-.95
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Chromite	lb.	...	.0215
Cerium hydrate 100 lb. drums and 600 lb. barrels	lb.	...	.65
Chrome Oxide Green, 400 lb. bbls.	lb.	.17	.215-.25
Cobalt oxide (Co_2O_3) In bbls.	lb	...	1.41
In 10 lb. tins	lb.	...	1.51
Copper oxide Red (Cu_2O)	lb.	...	.20
Black (CuO)	lb.	...	.15
Black prepared	lb.	...	.22
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08½	.09
Feldspar— 20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%) Bulk, carloads, f. o. b. mines	ton	31.50	...
In bags	ton	33.10	38.00-40.60
Formaldehyde, bbls.	lb.	...	.07
Graphite (C)	lb.	...	.04-.07
Iron oxide— Red (Fe_2O_3)	lb.	...	.0425
Black (Fe_3O_4)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Kaolin (f. o. b. mine)	ton	8.00-9.00	..
English, lump, f. o. b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	...	.16
Lead oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0710	...
In 5 Ton lots	lb.	...	.075
Less than 5 Tons	lb.	...	.08

		Carlots	Less Carlots
Lime— Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Limestone ($CaCO_3$)	ton	1.75	...
Litharge (PbO) (New York Prices)	lb.	.0610	...
In 5 Ton lots	lb.		.065
Less than 5 Tons	lb.		.07
Magnesium carbonate ($MgCO_3$)	lb.	.0610	.08-.09
Magnesium sulphate (U.S.P.)	lb.	...	.0275
Manganese, Black Oxide In Paper bags	ton	47.50	50.50
In Burlap bags	ton	49.50	52.50-57.50
In Casks	ton	51.50	54.50-59.50
Neodymidm oxalate, 50 lb. drums	lb.	...	$3.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Plaster of Paris, bags	ton	31.00	23.00 29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb.	...	.09
Powdered	lb.	...	.09½
Potassium carbonate Calcined (K_2CO_3) 96-98%	lb.	.06⅞	.07⅜
Hydrated 80-85%	lb.	.06	.06¼-.06⅜
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	...	.27
Potassium hydrate (KOH) (caustic potash)	lb.	.06¼-.06½	.08-.08½
Potassium nitrate (KNO_3) (gran.)	lb.	.0545	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	...	.19
Powder blue	lb.	...	.18¾-.19¼
Rare earth hydrate 100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Rochelle salts, bbls.	lb.	...	.12½
Rouge	lb.	...	Po. or Gr. .13½ / Cry.
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Silver nitrate ($AgNO_3$) . (100 oz. bot.)	per oz.	...	.39
Soda ash (Na_2CO_3) dense, 58%— Bulk	Flat Per 100 lb.	1.10	...
In barrels	Per 100 lb.	1.50	...
In bags	Per 100 lb.	1.25	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06½	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	...	.08⅜
Sodium fluosilicate (Na_2SiF_6)	lb.	.07	.0725
Sodium hydrate (NaOH) (caustic soda) Flake	Per 100 lb.	3.00	...
Solid	Per 100 lb.	2.60	...
Sodium nitrate ($NaNO_3$)— Refined (gran.) in bbls.	Per 100 lb.	...	2.00-2.25
95% and 97% Bulk	Per 100 lb.	1.25	...
200 lb bags		1.34	1.39
100 lb. bags		1.375	1.425
Sodium selenite (Na_2SeO_3)	lb.	..	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	...	1.50-1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)— Flowers, in bbls.	Per 100 lb.	3.35	3.70 4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Tin chloride ($SnCl_2$) (crystals) in bbls.	lb.	...	.35
Tin oxide (SnO_2) in bbls.	lb.	...	$.49
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	2.25
Yellow orange	lb.	...	1.50
Zinc oxide (ZnO) American process, Bags	lb.	.05¼	.05½
White Seal, 150 lb. bbls.	lb.	.07	.07¼
Green Seal bags	lb.	.06¼	.06½
Domestic White Seal bags	lb.	.06¾	.07
Red Seal, bags	lb.	.05¾	.06
Zircon Granular (Milled .005-.02c higher)		.07	.67½-.08
Crude. Gran. (Milled .005-.02c higher)		.03½	.04-.05

P. B. Sillimanite Feeder Parts

Defy the intense heat of 2300 degrees

From Clay Spouts lasting a little more than two weeks to a P. B. Sillimanite Feeder Spout giving absolute satisfaction for more than four months—that's the experience of one enthusiastic user.

The Spout was in service on a No. 4 tank handling Glasbake heat-resisting glass, from April 7 to August 22, with the temperature at 2300 degrees.

Even then it was in a usable condition for a much longer period. In fact, there was a loss of only ¼-inch in wall thickness during this very severe service.

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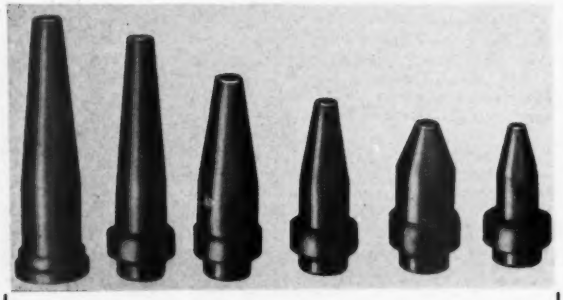

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